# INSTALLATION RESTORATION PROGRAM

# FEASIBILITY STUDY FOR SITE 1, SITE 3, AREA OF CONCERN A, AND AREA OF CONCERN B

FINAL

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110th FIGHTER GROUP
BATTLE CREEK, MICHIGAN

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C Responsiveness Summary

## ACRONYM LIST

| | |
|---|---|
| AFCEE | Air Force Center for Environmental Excellence |
| ANG/CEVR | Air Nation Guard Civil Engineering Environmental Installation Restoration Program |
| ANGRC | Air National Guard Readiness Center |
| AOC | area of concern |
| AOP | advanced oxidation process |
| ARARs | applicable or relevant and appropriate requirements |
| bgs | below ground surface |
| BTEX | benzene, toluene, ethylbenzene, and xylene |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CFR | Code of Federal Regulations |
| cis-1,2-DCE | cis-1,2-dichloroethene |
| cu yds | cubic yards |
| DOD | U.S. Department of Defense |
| F | Fahrenheit |
| FS | Feasibility Study |
| ft | feet |
| GAC | granulated activated carbon |
| gpm | gallons per minute |
| GRAs | general response actions |
| HAZWRAP | Hazardous Waste Remedial Actions Program |
| HMTC | Hazardous Materials Technical Center |
| IRP | Installation Restoration Program |
| MCLs | maximum contaminant levels |
| MDEQ | Michigan Department of Environmental Quality |
| MDNR | Michigan Department of Natural Resources |
| MERA | Michigan Environmental Response Act |
| mg/kg | milligram per kilogram |
| mi | miles |
| MIANG | Michigan Air National Guard |
| msl | mean sea level |
| MTV | mobility, toxicity, and volume |

## ACRONYM LIST

| | |
|---|---|
| NCP | National Contingency Plan |
| O&M | operations and maintenance |
| Op Memo | Operational Memorandum |
| PA | Public Act |
| PAHs | poly-nuclear aromatic hydrocarbons |
| PCBs | polychlorinated biphenyls |
| PCE | tetrachloroethene |
| POL | petroleum, oils, and lubricants |
| POTW | publicly owned treatment works |
| RAOs | remedial action objectives |
| RI | Remedial Investigation |
| RI/FS | Remedial Investigation/Feasibility Study |
| SARA | Superfund Amendments and Reauthorization Act |
| SDWA | Michigan Safe Drinking Water Act |
| SI | Site Inspection |
| sq ft | square feet |
| SVE | soil vapor extraction |
| SVOCs | semi-volatile organic compounds |
| USEPA | U.S. Environmental Protection Agency |
| ug/kg | micrograms per kilogram |
| ug/l | micrograms per liter |
| UV | ultraviolet |
| VOCs | volatile organic compounds |

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## EXECUTIVE SUMMARY

This Feasibility Study (FS) Report has been prepared for the Air National Guard Readiness Center under the U.S. Department of Defense Installation Restoration Program (IRP). The purpose of this FS is to screen and evaluate remediation alternatives for IRP sites and areas of concern (AOC) at the Kellogg Memorial Airport in Battle Creek, Michigan that have previously been identified as having contaminated soil and/or groundwater. Specifically, this report addresses the following sites and AOCs:

- Site 1 (Fuel Tank Farm) and AOC B (Motor Pool Drainage Ditch). Site 1 and AOC B have been combined due to proximity;
- Site 3 (Fire Training Area); and
- AOC A (Waste Accumulation Area).

The evaluations made in this report are based in part on information presented in the *Internal Draft Remedial Investigation (RI) Report*, June 1995, and the *Internal Draft Preliminary Assessment/Site Inspection (SI) Report*, February 1995, both prepared by Earth Technology Corporation.

The recommended remediation alternative for each site and AOC are as follows:

- Site 1 and AOC B - Soil Cap for Soil and Natural Attenuation for Groundwater;
- Site 3 - Clay Cap and In-Situ Soil Treatment (Soil Vapor Extraction) for Soil and In-Situ Groundwater Treatment (Air Sparging) for Groundwater; and
- AOC A - Limited Action for Soil and Investigation of Groundwater.

# 1.0 INTRODUCTION

This Feasibility Study (FS) Report has been prepared for the Air National Guard Readiness Center (ANGRC) under the U.S. Department of Defense's (DOD) Installation Restoration Program (IRP). The purpose of this FS is to screen and evaluate potential remediation alternatives for IRP sites and areas of concern (AOC) at the Kellogg Memorial Airport in Battle Creek, Michigan that have previously been identified as having contaminated soil and/or groundwater. This FS has been prepared pursuant to the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). Montgomery Watson has been contracted to prepare this FS report under contract DAHA90-94-D-0013, Delivery Order 13.

## 1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of this FS is to develop, screen, and evaluate remedial alternatives which are potentially capable of meeting the remedial action objectives (RAOs) identified for the sites at Kellogg. The first step in the FS process is to identify the RAOs and general response actions (GRAs). RAOs consist of media-specific or site-specific goals for protecting human health and the environment. GRAs are actions that satisfy the remedial action goals.

After the identification of the RAOs and the GRAs, the next step in the FS process is to identify and screen technologies. In this step, the universe of potentially applicable technology types and process options are reduced by evaluating the options with respect to technical implementability. The retained technologies are then combined to form remedial alternatives capable of meeting the RAOs applicable to a particular site. These remedial alternatives are then screened based on effectiveness, implementability, and cost. The purpose of this screening is to reduce the number of alternatives that must undergo a more thorough and extensive evaluation during the detailed analysis step.

The final step in the FS process is the detailed analysis of remedial alternatives. The remedial alternatives are evaluated against nine criteria developed by the U.S. Environmental Protection

Agency (USEPA) to address CERCLA requirements (USEPA, 1988). Suitable alternatives are then compared against each other to select the recommended alternative.

By direction of the ANG/CEVR, the process used in the preparation of this FS report has been streamlined in an effort to reduce the number of technologies and alternatives screened during the preliminary steps of the FS process. The evaluation of the regulatory framework, the development of the RAOs and GRAs, the identification and screening of technologies, and the development of remedial alternatives are based on media specific categories (i.e., soil and groundwater). This approach results in fewer repetitive alternatives during the initial screening process. The final detailed evaluation and recommendation of remedial alternatives is completed on a site by site basis. This streamlined approach is effective for the Kellogg sites since the sites exhibit similar types of contamination. The initial screening of media specific categories provides sufficient information to retain the most applicable alternatives for the site by site detailed analysis.

This FS report is divided into the sections outlined below:

- Section 1.0 - *Introduction.* This section contains the purpose and organization of the report; background information on Kellogg, including site descriptions and history; a brief summary of the nature and extent of the contaminants; a qualitative discussion of potential contaminant fate and transport; and a summary of the risk characterization. In addition, Section 1.0 presents information on the streamlined process used in the development of this FS report.

- Section 2.0 - *Remedial Action Objectives and General Response Actions.* This section presents the media specific categories developed for the Kellogg sites that are used in the analysis in Sections 3.0 and 4.0. In addition, this section discusses the Applicable or Relevant and Appropriate Requirements (ARARs), establishes the RAOs and the GRAs for the sites, and presents the identification and screening of remedial technologies.

- Section 3.0 - *Development and Screening of Alternatives.* This section presents the initial screening of the media specific alternatives based on the technologies retained in Section 2.0.

- Section 4.0 - *Detailed Analysis of Alternatives.* This section includes the development and evaluation of alternatives for each of the Kellogg sites using the evaluation criteria recommended by the USEPA. In this section, the media specific alternatives retained in Section 3.0 are combined into site specific alternatives for each of the Kellogg sites. Each alternative is subjected to a detailed analysis using the USEPA's nine criteria for evaluating remedial alternatives.

- Section 5.0 - *Recommended Alternatives.* This section presents recommended remedial alternatives.

- Section 6.0 - *References*

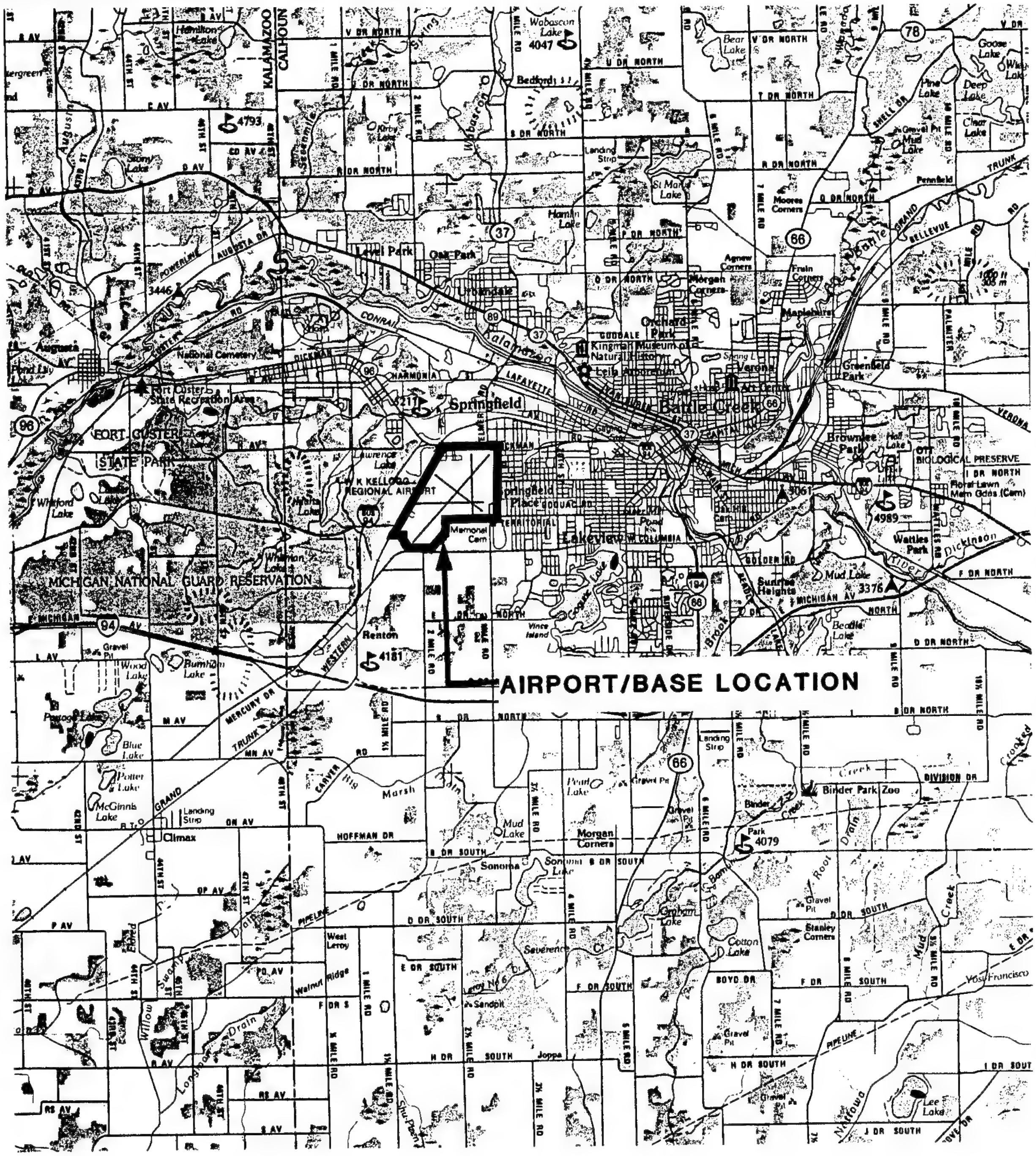
## 1.2 BACKGROUND INFORMATION

This section summarizes background information for Kellogg, including the location, description of past operations, geology, hydrogeology, nature and extent of contamination, contaminant fate and transport, and the risk characterization. This information was condensed from the *Internal Draft Remedial Investigation Report* (RI Report) (The Earth Technology Corporation, 1995).

### 1.2.1 Base Description

The base is located in south-central Michigan at the W.K. Kellogg Memorial Airport in southwest Battle Creek, Calhoun County (Figure 1-1). The base occupies 315 acres in the northwestern portion of the airport, approximately 204 acres are separated from the main portion of the base by the Grand Trunk Western Railroad.

Kellogg is located within the Central Lowland Physiographic Province of the Interior Plains. This region is characterized by a vast plain, and relatively low altitude of 500 to 2,000 feet (ft) above

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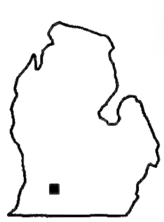

## NOTE

BASE MAP DEVELOPED FROM THE MICHIGAN ATLAS AND GAZETTEER PAGE 29, FOURTH EDITION SECOND PRINTING.

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**GENERAL LOCATION MAP**

**FIGURE 1-1**

**MONTGOMERY WATSON**

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mean sea level (msl). The physical characteristics of the facility are more thoroughly discussed in the RI Report.

### 1.2.2 Base History

Prior to 1924, the property on which the base is located was used for agricultural purposes. In September 1924, a lease with an option to buy was signed by the Battle Creek Chamber of Commerce. Four years later, W.K. Kellogg donated the necessary money to purchase and make improvements to the site for use as an airport. The Army Air Corps utilized the airport for combat duty training and to stage crews for overseas deployment from 1942 to 1946. During this time, new runways were constructed and existing runways were lengthened. Buildings were also erected to house base personnel and to support military functions.

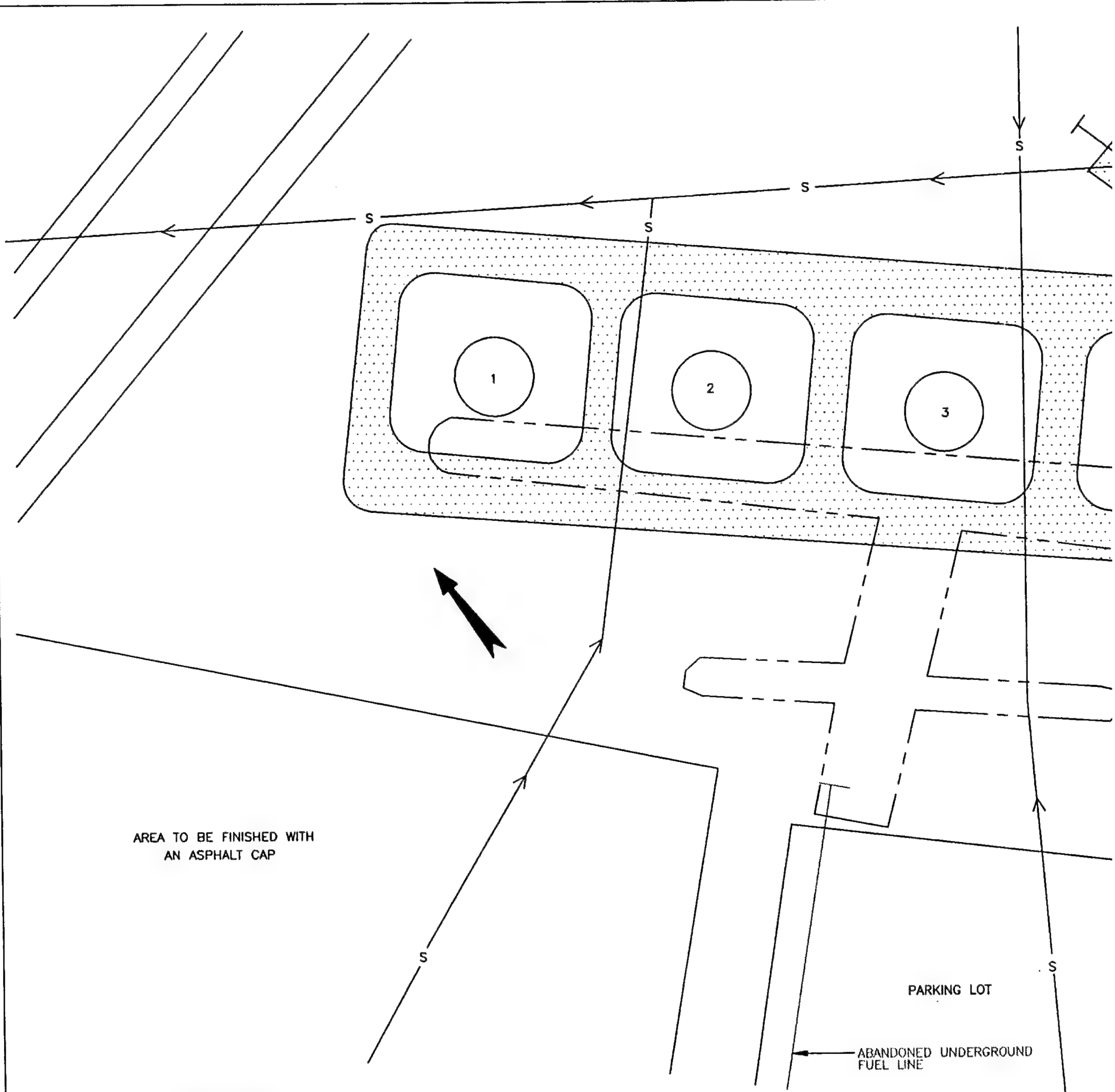
In 1946 the Army Air Corps ceased using the airport, the 172nd Fighter Squadron of the Michigan Air National Guard (MIANG) was formed, and Kellogg Field was designated as its headquarters. In 1951, the unit was called to active duty as part of the 56th Fighter Wing at Selfridge Air Force base in Michigan. The unit was redesignated as the 172nd Fighter Bomber Squadron when it returned to Kellogg the following year. In 1955, the unit was reorganized as the 172nd Fighter Interceptor Squadron and was upgraded to the 110th Fighter Group in 1956. This unit was deactivated and redesignated the 172nd Tactical Reconnaissance Squadron in 1958. In 1962, the 172nd Tactical Reconnaissance Squadron became the 110th Tactical Reconnaissance Group. This unit was replaced by the 110th Tactical Air Support Group in 1971. In 1986, the area that the base occupied was increased from approximately 90 acres to 315 acres. In 1992, the unit was reorganized as the 110th Fighter Group and assigned the A-10 aircraft which it currently operates. Throughout its history, the base has stored and used various types of potentially hazardous materials in support of its primary fighter mission.

The following is a brief discussion of each of the Kellogg sites included in this FS. Additional information regarding the Kellogg sites can be found in the *Internal Draft Remedial Investigation Report*, June 1995, and the *Internal Draft Preliminary Assessment/Site Investigation Report*, February 1995, both prepared by The Earth Technology Corporation.

**1.2.2.1 Site 1 - Fuel Tank Farm and Area of Concern B - Motor Pool Drainage Ditch.** These sites are located near the drainage swale, northwest of the motor pool parking lot. Site 1 originally contained four 25,000-gallon aboveground fuel storage tanks surrounded by containment berms. The storage tanks which were dismantled and removed from the base in 1988. The old foundations for the tanks still remain at the site. Prior to 1949, the tanks were used for storage of gasoline. The tanks were not used between 1949 and 1973. From 1973 to 1974, the city of Battle Creek used the tanks for the storage of No. 4 heating fuel. The tanks were patched prior to use by the city. Leakage reportedly occurred at some of the patches. Containment berms were spread on the surrounding land area in 1985. Site 1 is shown in Figure 1-2.

Area of Concern (AOC) B is the motor pool drainage ditch. This area borders Site 1 on the east side. The ditch has directed runoff from the motor pool to the drainage swale since 1963. During this time, routine vehicle maintenance activities occurred at the motor pool for approximately 100 vehicles. The motor pool is equipped with an oil/water separator through which the runoff was passed prior to discharge to the motor pool drainage ditch. AOC B is shown in Figure 1-2.

**1.2.2.2 Site 3 - Fire Training Area**. Site 3 is located on the western part of the base, southwest of the Civil Engineering storage yard. The fire training area is approximately 85 ft in diameter and surrounded by an earthen berm. Fire training exercises were conducted at this site from approximately 1977 to 1986. During this time, approximately 54,000 to 74,000 gallons of a mixture consisting of waste JP-4, waste oils, waste hydraulic fluid, and spent cleaning solvents were reportedly burned during fire training exercises (HMTC, 1987). The mixture of wastes was floated on top of water, ignited, and extinguished. An area where drums of waste were stored prior to utilization in fire training exercises is located north of the fire training area. A bioventing system, including blower and vent well, has previously been installed at this site. Site 3 is shown in Figure 1-3.

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| —S— | STORM DRAINS |
| -X—X- | FENCE |
| — — — — | EXCAVATED IN 1992 |
| ➡ | GROUNDWATER FLOW DIRECTION |
| (1) | ABOVEGROUND STORAGE TANK (PRE-EXISTING) |
| ═══ | ROADS |

## NOTES:

THE SURFACE ELEVATION OF SITE 1 AND AOC A IS APPROXIMATELY 920 FT MSL ± 5 FT (THE EARTH TECHNOLOGY CORPORATION, JUNE 1995)

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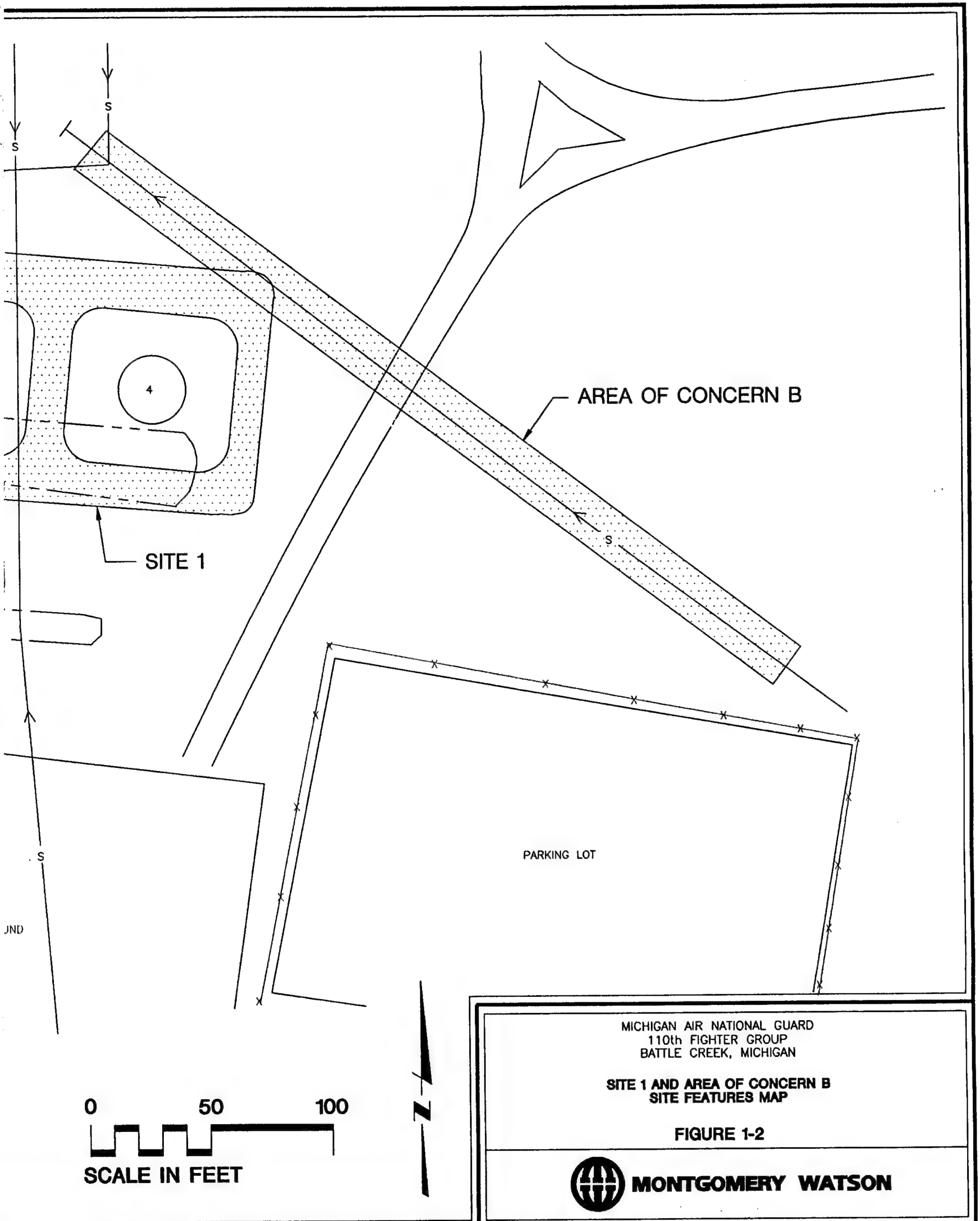
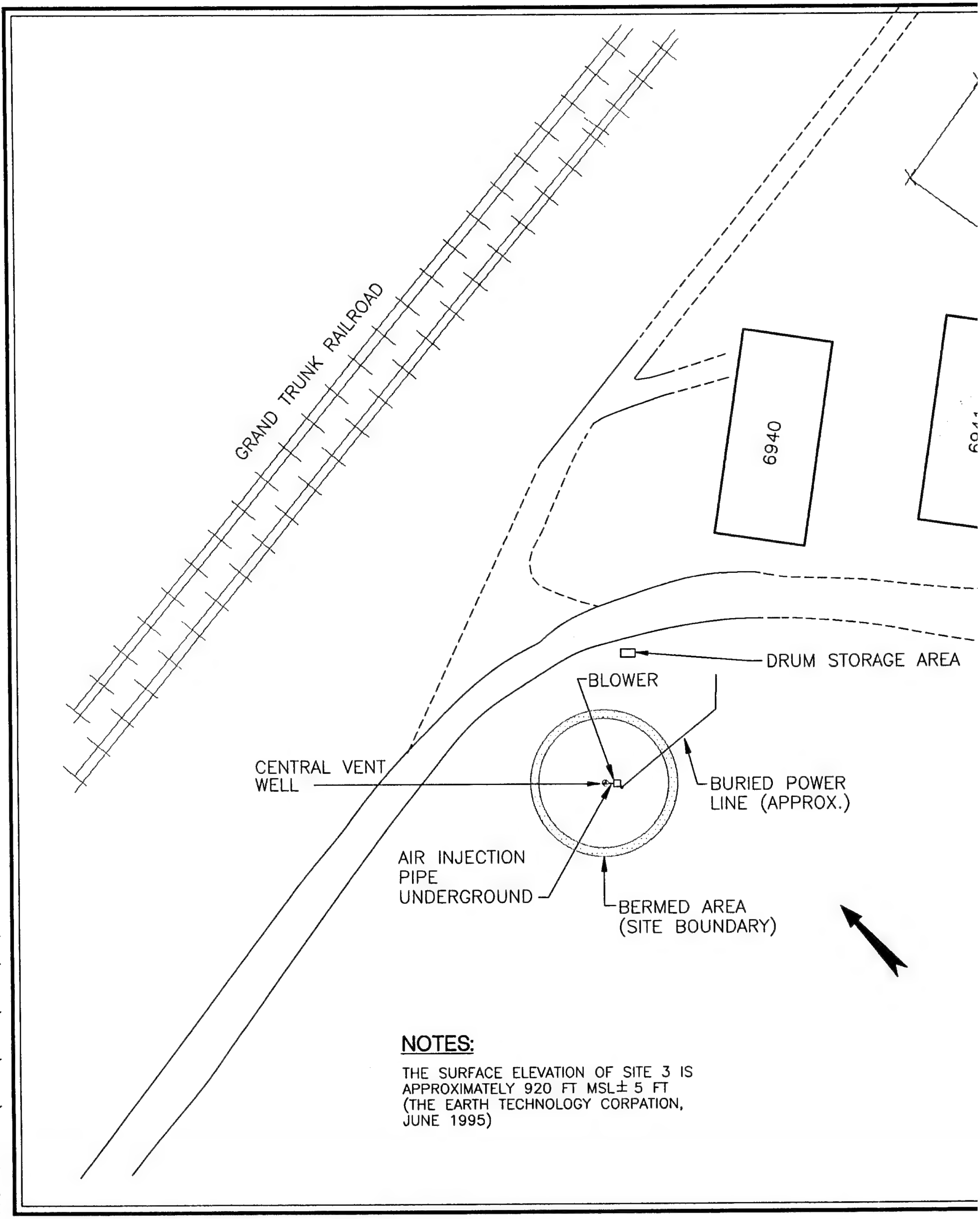



MICHIGAN AIR NATIONAL GUARD
110th FIGHTER GROUP
BATTLE CREEK, MICHIGAN

**SITE 1 AND AREA OF CONCERN B**
**SITE FEATURES MAP**

**FIGURE 1-2**

**MONTGOMERY WATSON**




**NOTES:**

THE SURFACE ELEVATION OF SITE 3 IS APPROXIMATELY 920 FT MSL± 5 FT (THE EARTH TECHNOLOGY CORPATION, JUNE 1995)

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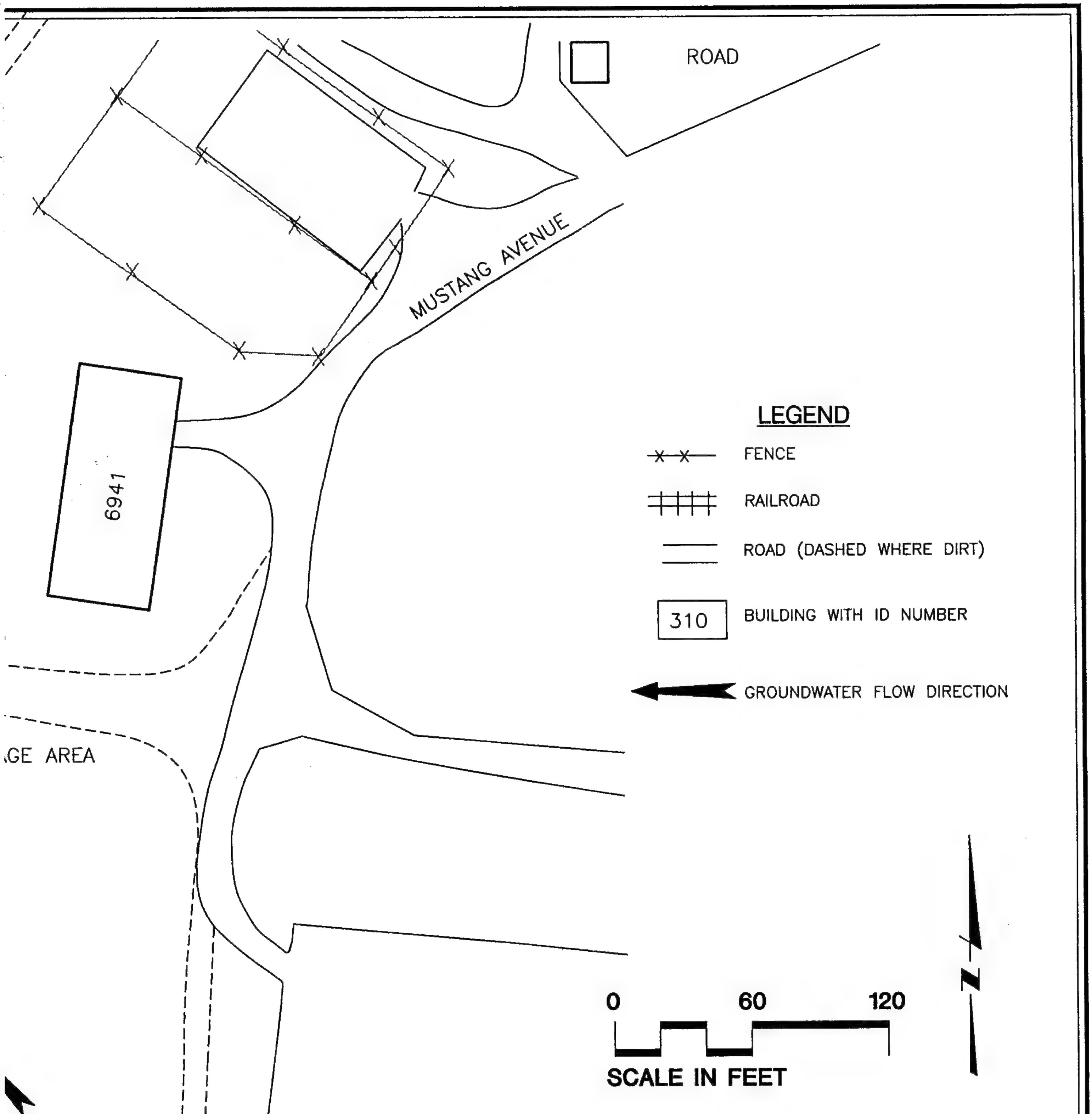


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**SITE 3 SITE FEATURES MAP**

**FIGURE 1-3**

**MONTGOMERY WATSON**

**1.2.2.3 Area of Concern A - Waste Accumulation Area.** This area consists of a grass-covered area east of the Civil Engineering Building. A section approximately 10 ft wide and 40 ft long was used for waste collection and storage. According to base personnel, this area was used as a petroleum, oils, and lubricants (POL), and solvent collection and storage area prior to 1980. Drums were used to collect waste oils, fuels, and solvents which were generated from the various shops on the base. It was reported that some spillage occurred. It is estimated that less than 5 gallons of this waste were spilled per month. When full, the barrels were removed from the area. The area believed to be contaminated as a result of activities at AOC A is shown on Figure 1-4.

### 1.2.3 Nature and Extent of Contamination

This section briefly (and generally) summarizes analytical data presented in the RI Report. Additional information regarding contaminants at these sites is presented in Section 2. Soil and groundwater media were investigated at Kellogg. Soil sampling was completed for each of the sites. Groundwater samples were collected from Site 1, AOC B, and Site 3.

**1.2.3.1 Soil.** Soil samples were collected from all of the Kellogg sites included in this FS. The samples were analyzed (volatile organic compounds [VOCs], semi-volatile organic compounds [SVOCs], and metals) for contamination possibly caused by past operations at Kellogg. The various analytes detected in the samples from the sites are attributable to past operations at the sites. Constituents detected in the soil at Site 3 have also been detected in the groundwater at Site 3.

**1.2.3.2 Groundwater.** Groundwater samples were collected from all of the Kellogg sites included in this FS with the exception of AOC A. The samples were analyzed (VOCs, SVOCs, and metals) for contamination possibly caused by past operations at Kellogg. Site 1 groundwater has been contaminated by VOCs, SVOCs, and metals. Site 3 groundwater has been contaminated by VOCs and metals in the immediate vicinity of the bermed fire training area. Groundwater sampled from wells down gradient of Site 1, AOC B, and Site 3 had no detections of the constituents detected in the groundwater samples taken from wells at Site 1, AOC B, and Site 3.

### 1.2.4 Contaminant Fate and Transport

This section provides a brief summary of the contaminant fate and transport for chemicals of potential concern at the Kellogg sites. Refer to the RI Report for complete details on the information presented below.

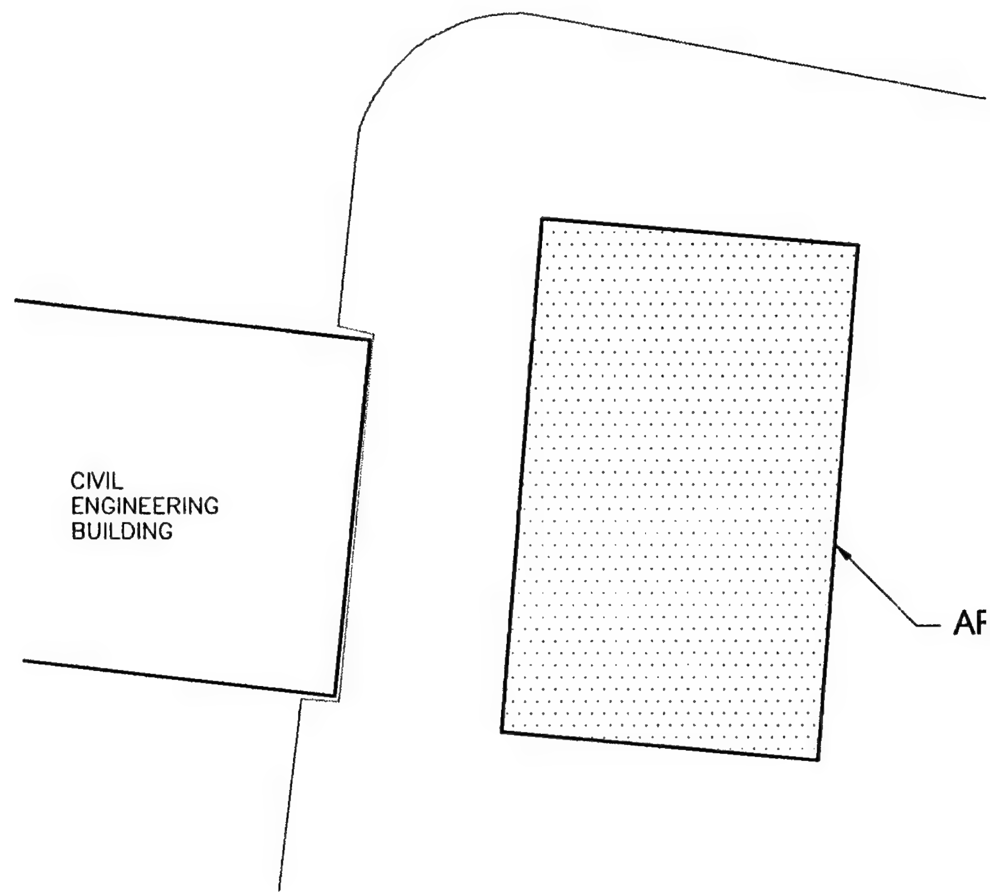
The release of contaminants into the environment and their subsequent transport and transformation are dependent on chemical and physical properties. These properties may included characteristics of the transporting media, specific properties of the contaminants, climatic conditions, and site-specific features.

Migration pathways define the route and method by which a chemical moves from the source to the potential receptor. Potential migration pathways for each of the Kellogg sites are listed in the risk characterization section of the RI Report.

Contaminants detected at the Kellogg sites were found in the soil and groundwater. VOCs are the most mobile constituents present and are likely to migrate the farthest regardless of the media (air, soil, or groundwater).

Based on the types of contaminants and concentrations which may be present at the Kellogg sites, volatilization of the VOCs through soils into surrounding air may be a contributing transport process. However, volatilization of chemical constituents to the atmosphere decreases with depth due to increased travel distance between the source and the atmosphere. During construction and/or excavation activities, the release of the contaminants to the air as particulates is possible, but manageable with dust control techniques.

**1.2.4.1 Groundwater Migration Pathway.** Groundwater is the migration pathway with the greatest potential for movement of contaminants. Contaminants with mid range to high water solubility, low $K_{oc}$ values (partition coefficient of a compound between organic carbon and water) and low retardation factors are more likely to migrate in the groundwater with little attenuation. However, the majority of organic contaminants detected in the groundwater at the sites (i.e.,




## NOTES:

1. DIMENSIONS OF AREA CONCERN A BASED ON FIGURE 4-1 OF THE INTERNAL DRAFT PRELIMINARY ASSESMENT / SITE INVESTIGATION REPORT (THE EARTH TECHNOLOGY CORPORATION, FEBRUARY 1995)

2. THE TOPOGRAPHY OF AOC A IS GENERALLY FLAT WITH LITTLE RELIEF IN ANY DIRECTION, (THE SURFACE ELEVATION IS UNKNOWN). ALTHOUGH GROUNDWATER WAS NOT INVESTIGATED AT AOC A, GROUNDWATER FLOW DIRECTION IS ASSUMED TO BE TO THE NORTHWEST BASED ON INFORMATION PRESENTED IN THE RI REPORT (THE EARTH TECHNOLOGY CORPORATION, JUNE 1995).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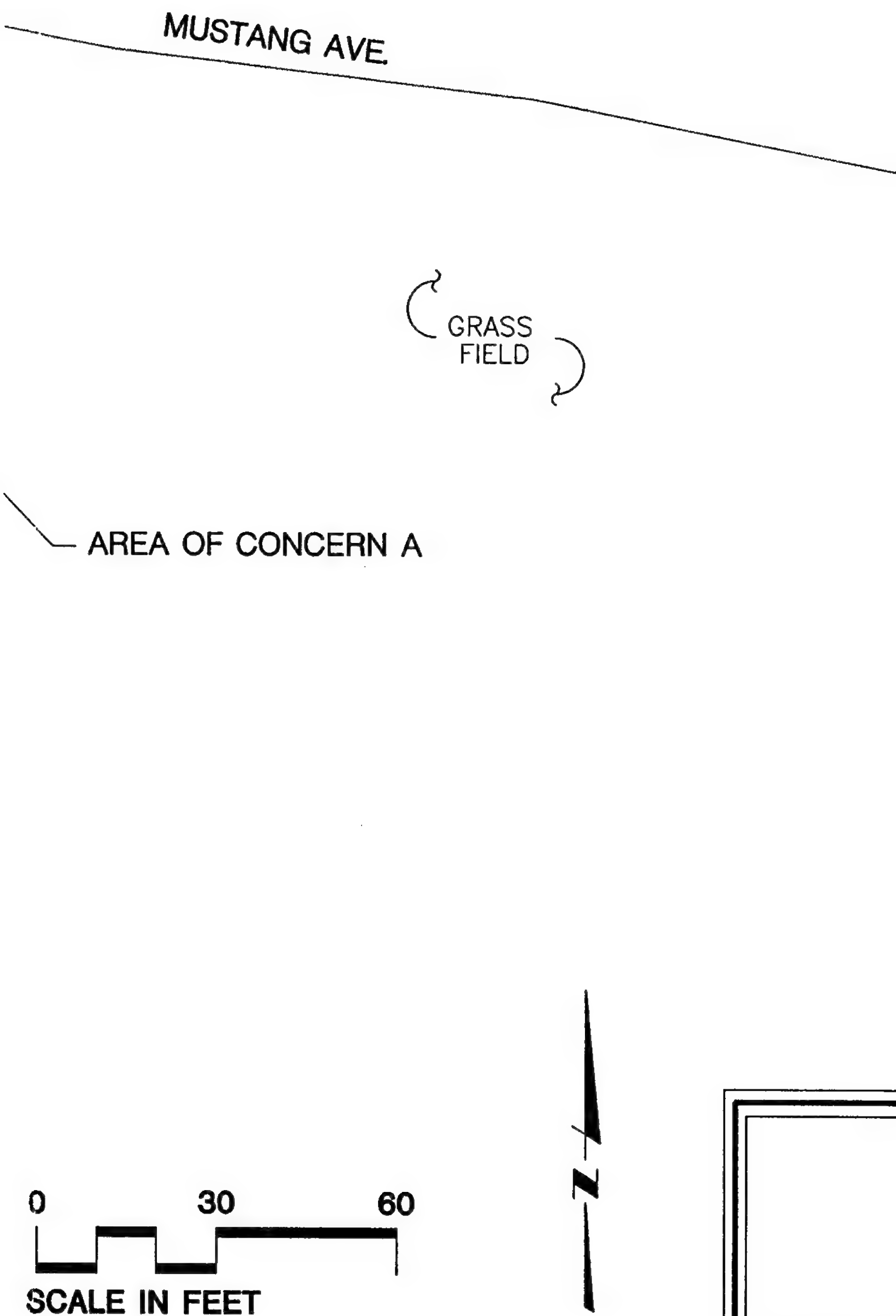


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**AREA OF CONCERN A SITE FEATURES MAP**

**FIGURE 1-4**

**MONTGOMERY WATSON**

tetrachloroethene, trimethylbenzenes, and phenanthrene) have moderate water solubilities, moderate $K_{oc}$ values, and moderate retardation factors. Therefore, they are likely to migrate slowly in the groundwater and be moderately attenuated. Furthermore, the trimethylbenzenes and phenanthrene readily degrade in the environment due to oxidation processes and natural bio-degradation processes. Tetrachloroethene also degrades through bio-degradation processes, but at a slower rate than trimethylbenzenes and phenanthrene.

With the exception of phenanthrene, the organic contaminants detected at the sites have moderate Henry's Law constants and will tend to partition readily into the vadose zone pore spaces and then the atmosphere.

The metals detected in the groundwater will tend to precipitate out of the groundwater due to oxidation and co-precipitation processes (USEPA, 1979) as the groundwater flows away from the source areas and will therefore be moderately attenuated in the groundwater.

**1.2.4.2 Soil Migration Pathway.** The organic compounds detected in the soils at the sites will tend to degrade naturally in the environment due to oxidation and bio-degradation processes. With the exception of phenanthrene, the organic constituents in the site soils have moderate Henry's Law constants and will tend to volatilize to the atmosphere.

Generally, metals in the soil will only migrate due to leaching or unsaturated liquid movement (advection). Attenuation processes which slow the movement of metals in the soil include precipitation and sorption/desorption. The metals detected above the Calculated Background Values at the Kellogg sites will tend to be attenuated by adsorption to the organic carbon in the soil and do not pose a significant threat of leaching. The metals detected most often in the soils are considered to be generally immobile in the environment due to oxidation processes.

### 1.2.5 Risk Characterization

A risk characterization was performed for Site 1 and AOC B during the development of the RI Report to assess the risks posed to human health by the contaminants detected in the soil at these

sites. The RI Report does not include a risk characterization for Site 3, AOC A, or area groundwater. The following is a summary of the risk characterization for Site 1 and AOC B.

**1.2.5.1 Site 1 - Fuel Tank Farm and AOC B - Motor Pool Drainage Ditch.** Exposure scenarios evaluated for Site 1 and AOC B in the RI Report risk characterization include the present use of land (soil) by base personnel and the future use of land (soil). Currently, complete pathways for soil include direct contact (ingestion and dermal absorption) by maintenance and ANG personnel with contaminated soil. Future pathways which are considered complete for the construction worker are incidental ingestion of contaminated soil, dermal contact with contaminated soil, and inhalation of contaminated fugitive dust. Based on the information presented in the RI Report, none of the complete pathways pose a risk greater than $1x10^{-5}$, which is the current level determined by the Michigan Department of Environmental Quality (MDEQ) to represent an acceptable risk. The non-cancer hazard index was determined in the RI Report risk characterization to be less than 1, indicating a low potential for adverse non-carcinogenic health affects. No risk characterization was performed for groundwater at Site 1 and AOC B.

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# 2.0 REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

This section discusses the identification of the ARARs, the development of the RAOs and GRAs, and preliminary screening of technologies.

## 2.1 INTRODUCTION

The FS process determines the ARARs, the development of the RAOs, and the identification of the GRAs. RAOs consist of media-specific or site-specific goals for protecting human health and the environment. GRAs describe those remedial actions that satisfy RAOs.

By direction of the ANG/CEVR, this FS report has been streamlined by generalizing the preliminary sections of the report. The identification of the ARARs, the development of the RAOs and GRAs, and the technology identification and screening presented in this section are discussed in general for media specific categories (i.e., soil and groundwater).

The identification of the ARARs is presented in Section 2.2, the development of the RAOs is presented in Section 2.3, the identification of the GRAs is presented in Section 2.4, and the screening of technologies is presented in Section 2.5. The analysis in each of these sections is based on the media specific categories.

## 2.2 PRELIMINARY IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs are environmental and public health statutes used in identifying site contamination which may pose human health or environmental concerns at a site. CERCLA as amended by SARA, and the National Contingency Plan (NCP) requires remedial actions to comply with ARARs.

The state of Michigan does not have an alternate definition of ARARs, therefore the definition contained in the federal regulations is presented below. According to the NCP (contained in Title 40 of the Code of Federal Regulations (CFR), Part 300), "applicable" and "relevant and appropriate" are defined as follows:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility citing law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

- Relevant and appropriate requirements are those cleanup standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility citing law that, while not "applicable" to hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

Neither SARA nor the NCP provides across the board standards for determining whether a particular remedy provides adequate cleanup at a particular site. Rather, the process recognizes that each facility has unique characteristics that must be evaluated and compared to those requirements that apply under a given circumstance.

SARA also requires compliance with state ARARs if they are more stringent than federal ARARs, legally enforceable, and consistently enforced statewide.

The ARARs are identified and considered at the following steps in the remedial process:

- As part of the remedial investigation/feasibility study (RI/FS) scoping;
- During the site characterization phase of the remedial investigation (RI);

- During the development of remedial alternatives;
- During detailed analysis of remedial alternatives;
- When an alternative is selected; and
- During the remedial design.

There are three general types of ARARs that remedial actions may have to comply with: action-specific; chemical-specific; and location-specific. Each type is explained below.

Action-specific ARARs are technology or activity based requirements or limitations placed on remedial activities. There are several action-specific requirements that may apply to the sites, depending on the determined remedial action of the site. For example, emitting off-gasses from remedial control technologies would have specific limitations which would need to be met. Additional considerations may include obtaining a construction permit if a treatment building is to be constructed on-site.

Chemical-specific ARARs are health or risk based concentration limits or limits specified by methodologies for various environmental media (i.e., groundwater, surface water, air, and soil), that are established for a specific chemical. These cleanup goals establish the acceptable amount or concentration of a chemical that may remain in, or be discharged to the ambient environment. If a chemical has more than one cleanup standard, the most stringent standard is established as the ARAR for that chemical. The chemical-specific ARARs for the media of concern are discussed in the following sections.

Location-specific ARARs are restrictions placed on a site solely due to the location of the site. Examples of special locations possibly requiring ARARs include wetlands, flood plains, sensitive ecosystems, critical habitats of threatened and endangered species, historic places, and archaeological sites. These locations are special due to the presence of important geographical features, biological features, or cultural resources.

### 2.2.1 ARARs for Soils

The potentially applicable ARARs that are considered in the evaluation of the soils at Kellogg follow.

**2.2.1.1 Action-Specific ARARs.** The following are ARARs that are potentially applicable to the soils based on activities or technologies required for remediation activities.

- Michigan Air Pollution Control Act of 1995, PA 451, Part 55. Sites requiring excavation during remedial action or technologies with off-gas streams may need a permit under Part 55, due to emissions of VOCs and or particulates.

- Michigan Soil Erosion and Sedimentation Control Act of 1995, PA 451, Part 91. Sites requiring excavation or earthwork may require installation of devices to prevent erosion.

**2.2.1.2 Chemical-Specific ARARs.** The following are ARARs based on current MDEQ guidelines for remediation of soils.

- Generic Industrial Cleanup Criteria for Soil Direct Contact (i.e., Industrial Direct Contact Values) as specified by Michigan PA 451, Part 201, as outlined in the Michigan Department of Natural Resources (MDNR) Michigan Environmental Response Act (MERA) Operational Memorandum (Op Memo) #14, Revision 2, June 6, 1995. These criteria have been developed utilizing specific risk and exposure algorithms intended to stimulate land use activity. When direct human contact with the soil is anticipated, the Industrial Direct Contact Values are used as an ARAR to ensure that levels in soil are protective of human health. (Although Kellogg is categorized as a subcategory II commercial land use facility; as outlined in Op Memo #14, subcategory II commercial facilities use the Generic Industrial Criteria for evaluation).

- Generic Industrial Cleanup Criteria for soil to be considered protective of groundwater as outlined in the MDNR MERA Op Memo #14, Revision 4, June 6, 1995. The

determination of a soil concentration protective of groundwater can be accomplished by several methods: 1) through the use of a leach test; 2) by comparison with 20 times the appropriate health based drinking water criterion (20 times the Industrial Drinking Water Values); or 3) by use of fate and transport modeling or perched in-situ groundwater evaluation, that demonstrates that hazardous substances in soil will not result in contamination to groundwater in excess of the criteria. Concentrations of constituents in the soil must be shown protective of groundwater for sites in which groundwater is used as a source of drinking water. Kellogg does not currently use and has no future plans for using the groundwater in the contaminated unconsolidated formation as a source of drinking water. However, since the groundwater beneath the base is an aquifer which could potentially be used as a drinking source in the future, soils at Kellogg will be evaluated under this criteria to determine if they are protective of groundwater.

- Calculated Background Values as specified by MDNR MERA Op Memo #15, September 30, 1993. Background concentrations were calculated for soil contaminants at the Kellogg sites per MDEQ guidelines and presented in the RI Report. These values are used in this FS as a guidance in evaluating soil contamination (i.e., background values are not used as mandatory cleanup levels when no risk to human health or the environment was identified at a site).

**2.2.1.3 Location-Specific ARARs.** No location specific ARARs are considered to be potentially applicable to soils at Kellogg.

**2.2.2 ARARs for Groundwater**

The potentially applicable ARARs that are considered in the evaluation of the groundwater at Kellogg follow.

**2.2.2.1 Action-Specific ARARs.** The following are ARARs that are potentially applicable to the groundwater based on activities or technologies required for remediation activities.

- Michigan Air Pollution Control Act of 1995, PA 451, Part 55. Technologies with off-gas streams may require a permit to discharge off-gases to the atmosphere.

- Michigan Public Act 451, Part 31, Water Resources Protection, February 1995. These regulations govern discharges of pollution to waters of the state. PA 451, Part 31 states that it is unlawful for any person directly or indirectly to discharge into the waters of the state any substance which is or may become injurious to public health, safety, or welfare. These include direct or indirect discharge to lakes and streams, injection into groundwater, and storm sewer discharges. These rules also apply to flood plains and discharges to storm sewers. Disposal of water to either a surface water body or to the groundwater will require a permit.

**2.2.2.2 Chemical-Specific ARARs.** The following are ARARs based on current MDEQ guidelines for remediation of groundwater.

- Federal Maximum Contaminant Levels (MCLs) as specified under the current federal maximum contaminant levels for drinking water as established under the Safe Drinking Water Act (40 CFR Part 141).

- Generic Industrial Cleanup Criteria for Health Based Drinking Water Value (i.e., Industrial Drinking Water Values) as specified by Michigan PA 451, Part 201 as outlined in the MDNR MERA Op Memo #14, Revision 2, June 6, 1995. These criteria have been developed utilizing specific risk and exposure algorithms intended to simulate land use activity. (Although Kellogg is categorized as a subcategory II commercial land use facility; as outlined in Op Memo #14, Kellogg groundwater is evaluated under the Industrial Drinking Water Values. For the remainder of this report, Kellogg will be referred to an industrial facility.)

**2.2.2.3 Location-Specific ARARs.** No location specific ARARs are considered to be potentially applicable to groundwater remediation at Kellogg.

## 2.3 IDENTIFICATION OF REMEDIAL ACTION OBJECTIVES

As defined by the USEPA, RAOs consist of goals for protecting human health and the environment (USEPA, 1988). The RAOs identified in this section serve as guidelines in the development and evaluation of remedial alternatives.

### 2.3.1 Development of RAOs for Soils

The RAOs for soils are goals for protecting human health and the environment, preventing or minimizing exposure to contaminants, and achieving compliance, where possible, with ARARs. The following is a list of the RAOs for soils at Kellogg.

- Achieve levels of contamination in site soils that are consistent with requirements of an industrial facility;

- Minimize contamination to groundwater caused by contaminated soils; and

- Prevent human exposure to contaminated soil causing an unacceptable risk to human health.

### 2.3.2 Development of RAOs for Groundwater

RAOs for groundwater are goals for protecting human health and the environment, preventing or minimizing exposure to contaminants and achieving compliance, where possible, with ARARs. The RAOs for groundwater include the following:

- Achieve levels of contamination in site groundwater consistent with requirements of Federal MCLs, Michigan Safe Drinking Water Act (SDWA), and for a subcategory II commercial land use facility; and

- Prevent human exposure to contaminated groundwater causing unacceptable risks to human health.

## 2.4 IDENTIFICATION OF GENERAL RESPONSE ACTIONS

In accordance with CERCLA guidance, once the RAOs for a site have been established, the next step in developing remedial measures is to identify GRAs that may be taken to satisfy the RAOs. Response actions are selected on the basis of their applicability to the characteristics and chemicals at a given site. In some cases, a single response action may be capable of meeting all of the RAOs, but the combination of response actions may prove to be more effective. As a baseline comparison, the no action response action is considered and carried through to the detailed analysis step.

The GRAs also include an estimate of the volumes which may require treatment. The extent of the contaminated areas requiring remediation may need to be characterized more completely for the Kellogg sites included in this FS, depending on the remedial alternative selected. For purposes of completing this FS and for evaluating remedial alternatives, assumptions have been made as to the extent of the contamination. Volume estimates in this section are preliminary.

### 2.4.1 GRAs for Soils

The GRAs for soils requiring remediation are listed below:

- No Action - Under the no action general response the current state of the soil is not changed.

- Limited Action (Natural Attenuation, Monitoring, Institutional Controls) - The limited action general response is typically enacted to prevent access to or use of contaminated soil until cleanup levels are met by natural attenuation and/or treatment.

- Containment - The containment response includes technologies that involve little or no treatment, but provide protection to human health and the environment by reducing the mobility of constituents in the soil and preventing human exposure to the constituents.

- In-situ Soil Treatment - In-situ soil treatment options remediate contaminated soil without excavating the soil.

- Aboveground Soil Treatment - Under this treatment option, soil is excavated and treated above ground. Treated soil is either returned to the excavation location or disposed in a suitable landfill.

- Soil Excavation and Disposal - Under this option, soil is excavated and disposed either in an on-site or off-site landfill suitable for receiving the contaminated soil.

In evaluating the sites that may require remediation, the detected contaminants are compared to chemical-specific ARARs. The contaminants detected in the soils are compared with the Industrial Direct Contact Criteria to determine if the contaminants pose a threat to human health. The results of the RI Report risk characterization are also considered in determining if contaminants pose a human health risk.

Contaminant concentrations are also evaluated to determine if these concentrations are protective of groundwater. The concentrations of inorganic contaminants are initially compared to Calculated Background Values to identify contaminants of potential concern for groundwater protection. If no Calculated Background Value exists for the contaminants then the detected concentration is compared to 20 times the Industrial Drinking Water Value.

Since there are no Calculated Background Values for organic contaminants, the organic contaminants are compared to the 20 times the Industrial Drinking Water Values to identify organic contaminants of potential concern for protection of groundwater.

One method for demonstrating that concentrations of contaminants in the soils are protective of groundwater is to analyze the groundwater at sites with soil contamination. If the contaminants detected in the soil are not found in the groundwater, then it can be concluded that the contaminants in the soil are not leaching to the groundwater.

**2.4.1.1 Site 1 - Fuel Tank Farm and AOC B - Motor Pool Drainage Ditch.**

A summary of contaminants of potential concern in the soil at Site 1 and AOC B is provided in Table 2-1. Based on an evaluation of these contaminants, the following will be addressed by this FS:

- Lead at concentrations exceeding the Industrial Direct Contact Criteria.

The evaluation of contaminants of potential concern is provided below.

Lead was detected above Calculated Background Values throughout Site 1 in the vicinity of tanks 1, 2, and 3. Soil samples with lead concentrations greater than the Calculated Background Value are included in Figure 2-1. Lead detections occurred at SB-1, SB-2, SB-3, and SB-12 at depths from 0 to 1 ft. All samples are located within 15 ft of the tanks. These lead detections are possibly the result of tank maintenance and painting over the 40 years of use. Residue from sand blasting or scraping the tanks to clean paint containing lead from the tanks likely caused the elevated levels. Groundwater samples taken at Site 1 had no indication of lead in excess of Industrial Drinking Water Values. Therefore, lead in the soil above the Calculated Background Values and below Industrial Direct Contact Values will not be addressed in this FS Report.

Based on information presented in the RI Report, one surface soil sample (SB-12) analyzed at Site 1 contained lead in excess of the Industrial Direct Contact Value at 0 to 1 ft. below ground surface. The surface soil sample was taken from inside the circular foundation ring for the western most tank (i.e., tank 1) and exhibited a lead concentration of 3,150 milligrams per kilogram (mg/kg). The Industrial Direct Contact Criteria for lead is 400 mg/kg.

For cost estimating purposes, the area with lead contamination in excess of Industrial Direct Contact Value has been estimated as a 30 ft diameter circle centered on the foundation of Tank 1. The depth of soil exceeding the Industrial Direct Contact Value for lead is assumed to be contained within the top 1 ft. The estimated contaminated volume is 26 cubic yards (cu yds). Figure 2-2 shows the area assumed to contain lead in excess of the Industrial Direct Contact Value.

**TABLE 2-1**
**Contaminants of Potential Concern in Soil**
**110th Fighter Group**
**Kellogg Memorial Airport**
**Battle Creek, Michigan**

| Soil Sample Location | Detected Contaminants | Depth of Detection (ft) | Detected Concentration (ug/kg) | Calculated Background[1] (ug/kg) | 20 Times the Industrial Drinking Water Value[2] (ug/kg) | Industrial Direct Contact Value [3] (ug/kg) |
|---|---|---|---|---|---|---|
| **SITE 1** | | | | | | |
| SB-1 | Lead | 0 to 1 | 27,350 | 21,000 | 80 | 400,000 |
| SB-2 | Lead | 0 to 1 | 37,500 | 21,000 | 80 | 400,000 |
| SB3 | Lead | 0 to 1 | 52,600 | 21,000 | 80 | 400,000 |
| SB5 | Arsenic | 20 to 22 | 9,200 | 6,570 | 1,000 | 83,000 |
| SB-9 | Arsenic | 0 to 1 | 21,400 | 6,570 | 1,000 | 83,000 |
| | Lead | 0 to 1 | 17,500 | 21,000 | 80 | 400,000 |
| SB-11 | Arsenic | 0 to 1 | 7,100 | 6,570 | 1,000 | 83,000 |
| SB-12 | Arsenic | 0 to 1 | 8,100 | 7,140 | 1,000 | 83,000 |
| | Lead | 0 to 1 | 3,150,000 | 21,000 | 80 | 400,000 |
| SB18 | Arsenic | 15 to 17 | 16,200 | 6,570 | 1,000 | 83,000 |
| SS13 | Arsenic | 0 to 1 | 8,500 | 7,140 | 1,000 | 83,000 |
| BC1-MW2 | Arsenic | 20 to 22 | 13,900 | 6,570 | 1,000 | 83,000 |
| BSB-1 | Arsenic | 0 to 1 | 7,600 | 6,570 | 1,000 | 83,000 |
| BSB-2 | Lead | 0 to 2 | 200,000 | 21,000 | 80 | 400,000 |
| | Zinc | 0 to 2 | 112,000 | 47,000 | 138,000 | 1.00E+09 |
| | Chromium | 0 to 2 | 58,100 | 19,100 | 1,000 | 1.0E+9 |
| BSB-3 | Arsenic | 0 to 2 | 8,700 | 6,570 | 1,000 | 83,000 |
| BSB-4 | Arsenic | 0 to 2 | 11,400 | 6,570 | 1,000 | 83,000 |
| | | 5 to 7 | 12,700 | 6,570 | 1,000 | 83,000 |

TABLE 2-1 (continued)

| Soil Sample Location | Detected Contaminants | Depth of Detection (ft) | Detected Concentration (ug/kg) | Calculated Background[(1)] (ug/kg) | 20 Times the Industrial Drinking Water Value[(2)] (ug/kg) | Industrial Direc Contact Value [(3)] (ug/kg) |
|---|---|---|---|---|---|---|
| **SITE 3** | | | | | | |
| ESSB-1 | Tetrachloroethene | 26 to 26.5 | 1,306 | (4) | 100 | 4.90E+05 |
| ESSB-2 | Tetrachloroethene | 2 to 2.5 | 430 | (4) | 100 | 4.90E+05 |
| ESSB-3 | Tetrachloroethene | 2 to 2.5 | 124 | (4) | 100 | 4.90E+05 |
| ESSB-4 | Tetrachloroethene | 2 to 2.5 | 7,800 | (4) | 100 | 4.90E+05 |
| | | 14 to 14.5 | 350 | (4) | 100 | 4.90E+05 |
| | | 21.5 to 22 | 980 | (4) | 100 | 4.90E+05 |
| ESSB-5 | Tetrachloroethene | 2 to 2.5 | 420 | (4) | 100 | 4.90E+05 |
| | | 14 to 14.5 | 260 | (4) | 100 | 4.90E+05 |
| ESSB-6 | Benzene | 27 to 27.5 | 20 | (4) | 100 | 8.50E+05 |
| | 2-Methylnaphthalene | 21 to 21.5 | 119 | (4) | (6) | (6) |
| | | 27 to 27.5 | 4,650 | (4) | (6) | (6) |
| | 1,3,5-Trimethylbenzene | 27 to 27.5 | 6,130 | (4) | 65 | 2.30E+06 |
| | 1,2,4-Trimethylbenzene | 27 to 27.5 | 10,160 | (4) | 86 | 3.10E+06 |
| | 1,2,3-Trimethylbenzene | 27 to 27.5 | 5,970 | (4) | (6) | (6) |
| | Tetrachloroethene | 2 to 3.5 | 490 | (4) | 100 | 4.90E+05 |
| BC3-SB1 | Antimony | 0 to 1 | 140 | NA | 120 | 1.60E+06 |
| | Antimony | 3 to 6 | 210 | NA | 120 | 1.60E+06 |
| | Cadmium | 0 to 1 | 2,200 | 1,200 | 100 | 2.30E+06 |
| | Lead | 0 to 1 | 356,000 | 21,000 | 80 | 400,000 |
| | Zinc | 0 to 1 | 62,300 | 47,000 | 138,000 | 1.00E+09 |
| BC3-SB2 | Antimony | Surface | 400 | NA | 120 | 1.60E+06 |
| | Cadmium | Surface | 2,200 | 1,200 | 100 | 2.30E+06 |
| | Chromium | Surface | 27,400 | 18,000 | 2,000 | 1.0E+9 |
| | Lead | Surface | 261,000 | 21,000 | 80 | 400,000 |
| | Zinc | Surface | 649,000 | 47,000 | 138,000 | 1.00E+09 |
| 3SB3 | Antimony | 0 to 1 | 720 | NA | 120 | 1.60E+06 |
| | | 3 to 6 | 150 | NA | 120 | 1.60E+06 |
| | Barium | 0 to 1 | 102,000 | 76,430 | 40,000 | 3.20E+08 |
| | Cadmium | 0 to 1 | 8,600 | 1,200 | 100 | 2.30E+06 |
| | Chromium | 0 to 1 | 61,900 | 18,000 | 2,000 | 1.0E+9 |
| | Copper | 0 to 1 | 42,200 | 32,000 | 80,000 | 1.70E+08 |
| | Lead | 0 to 1 | 609,000 | 21,000 | 80 | 400,000 |
| | Zinc | 0 to 1 | 217,000 | 47,000 | 138,000 | 1.00E+09 |

| Soil Sample Location | Detected Contaminants | Depth of Detection (ft) | Detected Concentration (ug/kg) | Calculated Background[1] (ug/kg) | 20 Times the Industrial Drinking Water Value[2] (ug/kg) | Industrial Direct Contact Value [3] (ug/kg) |
|---|---|---|---|---|---|---|
| **AOC A** | | | | | | |
| ASS01 | Phenanthrene | 0 to 1 | 1,600 | NA | 1,500 | 1.6E+07 |
| | Arsenic | 0 to 1 | 51,600 | 7,140 | 1,000 | 83,000 |
| | Lead | 0 to 1 | 58,200 | 21,000 | 80 | 400,000 |
| ASS02 | Phenanthrene | 0 to 1 | 2,800 | NA | 1,500 | 1.6E+07 |
| | Arsenic | 0 to 1 | 13,800 | 7,140 | 1,000 | 83,000 |
| | Barium | 0 to 1 | 76,700 | 76,430 | 40,000 | 3.20E+08 |
| | Lead | 0 to 1 | 62,000 | 21,000 | 80 | 400,000 |
| | Zinc | 0 to 1 | 53,800 | 47,000 | 138,000 | 1.00E+09 |
| ASS03 | Phenanthrene | 0 to 1 | 5,700 | NA | 1,500 | 1.6E+07 |
| | Arsenic | 0 to 1 | 6,500 | 7,140 | 1,000 | 83,000 |
| | Lead | 0 to 1 | 46,900 | 21,000 | 80 | 400,000 |
| ASB1 | Phenanthrene | 0 to 1 | 5,500 | NA | 1,500 | 1.6E+07 |
| | Arsenic | 0 to 1 | 39,600 | 7,140 | 1,000 | 83,000 |
| | | 5 to 7 | 75,400 | 6,570 | 1,000 | 83,000 |
| | Chromium | 0 to 1 | 23,000 | 19,100 | 2,000 | 1.0E+9 |
| | Lead | 0 to 1 | 124,000 | 21,000 | 80 | 400,000 |
| | | 5 to 7 | 33,000 | 21,000 | 80 | 400,000 |
| | Methylene Chloride | 5 to 7 | 180 | NA | 100 | 3.3E+6 |
| | Nickel | 5 to 7 | 299,000 | NA | 2,000 | 3.4E+8 |
| ASB2 | Arsenic | 0 to 1 | 8,700 | 7,140 | 1,000 | 83,000 |
| | Antimony | 0 to 1 | 3,500 | NA | 120 | 1.60E+06 |

Notes:
1) Calculated Background values from soil samples taken at Kellog, based on MDNR guidelines for determining background value Concentrations in ug/kg.
2) Values are 20 times the Industrial Drinking Water value from the Generic Industrial or Commercial Cleanup Criteria and Other Requirement MDNR Operational Memorandum #14, June 1995.
3) Industrial Direct Contact Values from the Generic Industrial or Commercial Cleanup Criteria and other Requirements, MDNR Operation Memorandum #14, June 1995.
4) There are no Background Concentrations required for this constituent. Twenty times the Industrial Drinking Water value is used for analysis this constituent.
5) NA indicates Not Available.
6) Value not established for this contaminant.

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Soils at Site 1 also contain arsenic in excess of Calculated Background Values. Arsenic concentrations greater than the Calculated Background Values were detected in surface soils at Site 1 near tanks 1, 2, and 3. These samples are designated SB-9, SB-11, SB-12, SB13, and SB-18 and are all located within 60 ft of the tanks. The arsenic detections are distributed farther from the tanks than the lead detections. In the mid 1980s the berms that provided secondary containment for the tanks were leveled and spread around at the site. Surface soil arsenic detections are well within the area where the soil from the berms would have been distributed. Similar to the lead detections, the arsenic detections are likely the result of past maintenance activities for the tanks including possible paint residues from sand blasting or scraping the tanks. Figure 2-1 shows arsenic detections above the Calculated Background Value.

Subsurface arsenic detections were found at Site 1 near an underground pipeline corridor. Soil samples SB-5 and BC1-MW2 both showed arsenic levels in excess of the Calculated Background Values. The pipeline corridor was excavated and the pipes that serviced the tank farm at Site 1 were removed. The subsurface arsenic detections were found between 20 to 22 ft below ground surface (bgs) which is approximately 5 ft above the water table. The groundwater samples taken from monitoring well BC1-MW2 contained arsenic at concentrations slightly higher than the established Industrial Drinking Water Value. Other groundwater samples taken in close proximity both downgradient and cross gradient to BC1-MW2 exhibited arsenic concentrations below the Industrial Drinking Water Values (Figure 2-10). None of the remaining water samples collected at Site 1 are contaminated with arsenic. The tanks were removed in 1985 and no other operations have taken place at Site 1 or AOC B in the last 10 years. This has provided ample time to demonstrate the effect the arsenic will have on the groundwater. Based on this information, arsenic contamination in groundwater appears to be minimal and contained to a small area. Soil leaching tests could be performed to verify that arsenic is not leaching to the groundwater. AOC B has soil contamination similar to Site 1 soils. In general, AOC B soils have higher concentrations of the contaminants than Site 1. AOC B was a drainage ditch until 1985 when a storm sewer culvert was installed in the ditch. When the culvert was installed, the soil at AOC B were excavated and then filled to bring the ditch level with the surrounding grade. These activities disturbed the original locations of the contamination.

SAMPLE SB-11

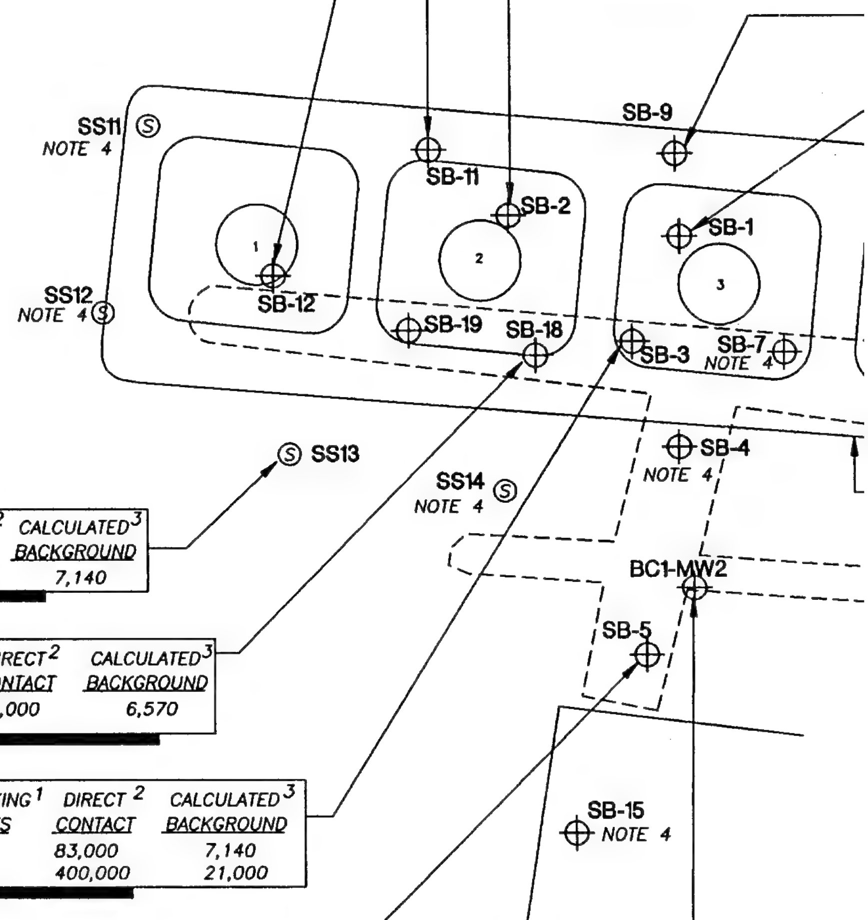
| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 19 TO 23ft. |
|---|---|---|
| ARSENIC [6] | 7,100 | NOTE 5 |

SAMPLE SB-12

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 20 TO 22ft. | 20 TIMES DRINKING [1] WATER VALUES | DIRECT [2] CONTACT | CALCULATED [3] BACKGROUND |
|---|---|---|---|---|---|
| ARSENIC [6] | 8,100 | NOTE 5 | 1,000 | 83,000 | 7,140 |
| LEAD | 3,150,000 | NOTE 5 | 80 | 400,000 | 21,000 |

SAMPLE SB-2

| COMPOUND | DE AT 0 TO 1ft. |
|---|---|
| ARSENIC [6] | NOTE 2 |
| LEAD | 37,500 |




SAMPLE SS13

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 20 TIMES DRINKING [1] WATER VALUES | DIRECT [2] CONTACT | CALCULATED [3] BACKGROUND |
|---|---|---|---|---|
| ARSENIC [6] | 8,500 | 1,000 | 83,000 | 7,140 |

SAMPLE SB18

| COMPOUND | DETECTED CONC. AT 15 TO 17ft. | 20 TIMES DRINKING [1] WATER VALUES | DIRECT [2] CONTACT | CALCULATED [3] BACKGROUND |
|---|---|---|---|---|
| ARSENIC [6] | 16,200 | 1,000 | 83,000 | 6,570 |

SAMPLE SB3

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 20 TO 22ft. | 20 TIMES DRINKING [1] WATER VALUES | DIRECT [2] CONTACT | CALCULATED [3] BACKGROUND |
|---|---|---|---|---|---|
| ARSENIC [6] | NOTE 5 | NOTE 5 | 1,000 | 83,000 | 7,140 |
| LEAD | 52,600 | NOTE 5 | 80 | 400,000 | 21,000 |

SAMPLE SB5

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 20 TO 22ft. | 20 TIMES DRINKING [1] WATER VALUES | DIRECT [2] CONTACT | CALCULATED [3] BACKGROUND |
|---|---|---|---|---|---|
| ARSENIC [6] | NOTE 5 | 9,200 | 1,000 | 83,000 | 6,570 |

SAMPLE BC1-MW2

| COMPOUND | DETECTED CONC. AT 10 TO 12ft. | 20 TO 22ft. | 2 |
|---|---|---|---|
| ARSENIC [6] | NOTE 5 | 13,900 | |

## LEGEND

1 FORMER ABOVE GROUND STORAGE TANK

SOIL BOREHOLE

S SURFACE SOIL SAMPLE LOCATION

------- EXCAVATED IN 1992

## NOTES:

1. 20 TIMES THE INDUSTRIAL DRINKING WATER VALUE FROM THE GENERIC INDUSTRIAL AND COMMERCIAL CLEANUP CRITERIA MDNR MERA OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN ug/kg.
2. DIRECT CONTACT VALUE FROM THE GENERIC INDUSTRIAL AND COMMERCIAL CLEANUP MDNR MERA OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN ug/kg.
3. CALCULATED BACKGROUND VALUES FROM SOIL SAMPLES TAKEN AT KELLOGG, BASED ON MDNR GUIDELINES FOR DETERMINING BACKGROUND VALUES. CONCENTRATIONS IN ug/kg.
4. NO IMI AT COI BACKG DIRECT
5. THIS C CONCE BACKG DIRECT
6. ARSEN CALCU BACKG AS 6,5

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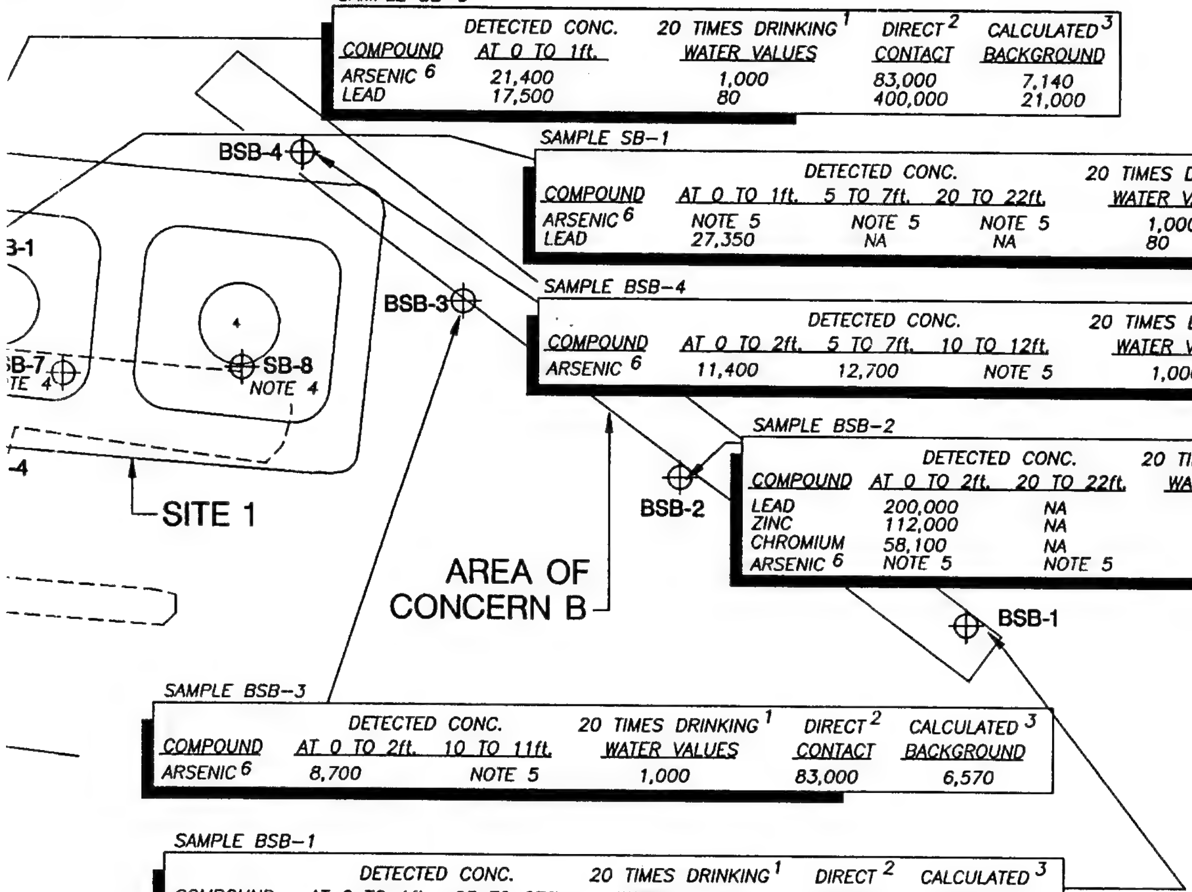


| ..D CONC. 19 TO 23ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|
| NOTE 5 | 1,000 | 83,000 | 6,570 |

| DETECTED CONC. AT 0 TO 1ft. | 10 TO 12ft. | 20 TO 22ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|---|---|
| NOTE 2 | NOTE 5 | NOTE 5 | 1,000 | 83,000 | 6,570 |
| 37,500 | NOTE 5 | NOTE 5 | 80 | 400,000 | 21,000 |

SAMPLE SB-9

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|---|
| ARSENIC [6] | 21,400 | 1,000 | 83,000 | 7,140 |
| LEAD | 17,500 | 80 | 400,000 | 21,000 |

SAMPLE SB-1

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 5 TO 7ft. | 20 TO 22ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|---|---|---|
| ARSENIC [6] | NOTE 5 | NOTE 5 | NOTE 5 | 1,000 | 83,000 | 7,140 |
| LEAD | 27,350 | NA | NA | 80 | 400,000 | 21,000 |

SAMPLE BSB-4

| COMPOUND | DETECTED CONC. AT 0 TO 2ft. | 5 TO 7ft. | 10 TO 12ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|---|---|---|
| ARSENIC [6] | 11,400 | 12,700 | NOTE 5 | 1,000 | 83,000 | 6,570 |

SAMPLE BSB-2

| COMPOUND | DETECTED CONC. AT 0 TO 2ft. | 20 TO 22ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|---|---|
| LEAD | 200,000 | NA | 80 | 400,000 | 21,000 |
| ZINC | 112,000 | NA | 138,000 | 1.00E+9 | 47,000 |
| CHROMIUM | 58,100 | NA | 1,000 | 1.00E+9 | 19,100 |
| ARSENIC [6] | NOTE 5 | NOTE 5 | 1,000 | 83,000 | 6,570 |

SAMPLE BSB-3

| COMPOUND | DETECTED CONC. AT 0 TO 2ft. | 10 TO 11ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|---|---|
| ARSENIC [6] | 8,700 | NOTE 5 | 1,000 | 83,000 | 6,570 |

SAMPLE BSB-1

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 25 TO 27ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|---|---|
| ARSENIC [6] | 7,600 | NOTE 5 | 1,000 | 83,000 | 6,570 |

| ..ONC. 20 TO 22ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|
| 13,900 | 1,000 | 83,000 | 6,570 |

0 65 130

SCALE IN FEET

4. NO IMPACTS WERE DETECTED FOR THIS SAMPLE AT CONCENTRATIONS OVER THE CALCULATED BACKGROUND VALUES AND THE INDUSTRIAL DIRECT CONTACT VALUES.

5. THIS CONSTITUENT WAS NOT DETECTED AT A CONCENTRATION ABOVE THE CALCULATED BACKGROUND VALUE OR THE INDUSTRIAL DIRECT CONTACT VALUE.

6. ARSENIC SURFACE BACKGROUND CONCENTRATION CALCULATED AS 7,140 ug/kg. ARSENIC SUBSURFACE BACKGROUND CONCENTRATION CALCULATED AS 6,570 ug/kg.

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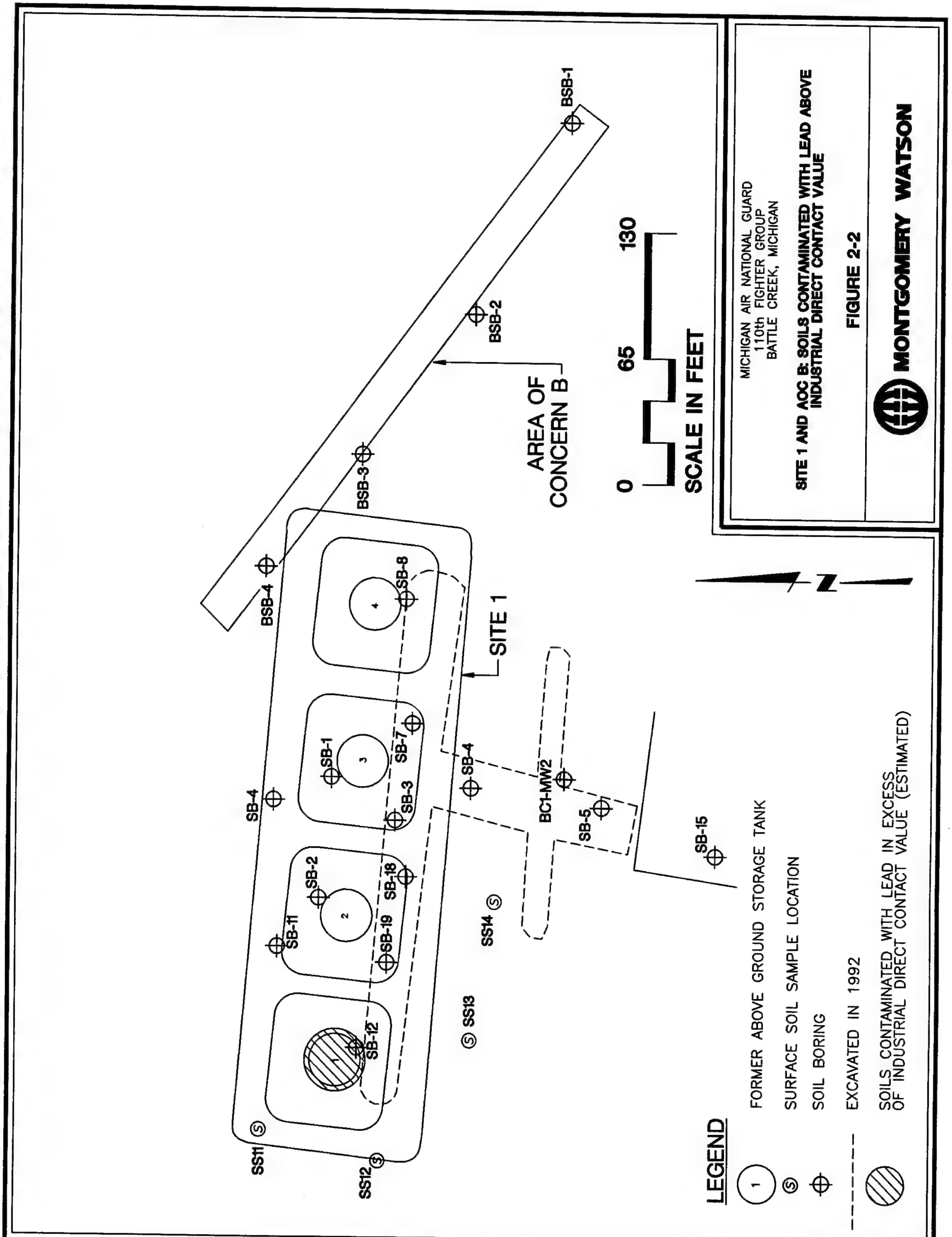
**SITE 1 AND AOC B: SOIL SAMPLES CHEMICALS OF POTENTIAL CONCERN**

**FIGURE 2-1**

**MONTGOMERY WATSON**

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**SITE 1 AND AOC B: SOILS CONTAMINATED WITH LEAD ABOVE INDUSTRIAL DIRECT CONTACT VALUE**

**FIGURE 2-2**

The soil at AOC B exhibits concentrations of arsenic, lead, chromium and zinc above Calculated Background Values. None of these inorganic detections were above the Industrial Direct Contact Values. Benzo(a)pyrene was also detected at three of the four soil borings. Benzo(a)pyrene was found to exceed 20 times the Industrial Drinking Water Values but did not exceed the Industrial Direct Contact Values. Benzo(a)pyrene, due to its physicochemical properties, is not expected to leach through soils to the groundwater, therefore, it is not considered a threat to human health or the environment. Therefore, benzo(a)pyrene will not be addressed by this FS Report.

Wells near and downgradient of AOC B exhibit none of the inorganic contaminants detected in the soils at AOC B. It can be concluded that the inorganic soil contaminants at AOC B are not leaching to the groundwater. Therefore, the inorganic contaminants in the soil at AOC B are not considered a threat to human health and the environment and will not be addressed by this FS Report.

The soil contaminants at AOC B could have been the result of cleaning activities in the motor pool area prior to 1985. An oil/water separator was used to trap oil from the maintenance shop adjacent to the motor pool. The water from the oil/water separator flowed into the ditch that is now labeled AOC B. The RI report stated that the oil/water separator was not emptied often and was used in the disposal of JP-4 from tanker trucks that required repairs. In addition, chemicals used to clean engines and motor parts were washed down the ditch to clean the motor pool area. Another possible source of contaminants in the soil, such as arsenic, may be the fill that was used to level the ditch. The bermed areas around the tanks at Site 1 were leveled at about the same time as the culvert was installed in AOC B. Soil could have been borrowed from the berm to backfill the ditch area.

#### 2.4.1.2 Site 3 - Fire Training Area.

A summary of contaminants of potential concern in the soil at Site 3 is provided in Table 2-1. Based on an evaluation of these contaminants, the following will be addressed by this FS:

- Lead at concentrations exceeding the Industrial Direct Contact Criteria;
- Tetrachloroethene (PCE) at concentrations exceeding 20 times the Industrial Drinking Water Value; and
- Trimethylbenzenes at concentrations exceeding 20 times the Industrial Drinking Water Value.

The evaluation of the contaminants of potential concern is provided below.

Soils contaminated with fuel and solvent related constituents have been identified at Site 3. It is assumed that these contaminants are the result of fire training exercises that took place between 1977 and 1986. The RI Report and the 1995 Air Force Center for Environmental Excellence (AFCEE) Bio-venting Report (AFCEE, 1995) indicate both organic and inorganic contaminants in soils near Site 3. Previously a bio-vent was installed to assess the use of bio-degradation to remediate BTEX constituents in the non-saturated soils. Results of the report indicate that the bio-vent is degrading BTEX compounds in the soils where the vent was installed.

Three soil borings were performed inside the bermed fire training area and analyzed for inorganic contaminants. Lead was detected in surface soil in excess of the Industrial Direct Contact Values at 3SB3 with a value of 609 mg/kg. The Industrial Direct Contact Value is 400 mg/kg. The remaining two soil borings both showed elevated concentrations of lead with values in excess of the Calculated Background Value at 3SB1 and 3SB2. The locations and detected lead concentrations are shown in Figure 2-3.

Soil samples 3SB1, 3SB2, and 3SB3 had detections of cadmium, chromium, and zinc over the Calculated Background Values. 3SB3 also contained barium and copper over the Calculated Background Values. None of the inorganic contaminants listed above were detected in down gradient or cross gradient monitoring wells.

Antimony was detected in all three soil borings (3SB1, 3SB2, and 3SB3) in excess of 20 times the Industrial Drinking Water Values. (There was no Calculated Background Value for antimony presented in the RI Report due to insufficient data.) Antimony was detected at 59 micrograms per liter (ug/l) in two of six monitoring wells at the site. The Industrial Drinking Water Value is 6 ug/1. The antimony in monitoring well MW-4 is immediately downgradient of the fire training pit. The antimony in MW-1 is approximately 100 ft upgradient from antimony detections in the soil. Antimony appears to be randomly distributed in the soils throughout the site.

For cost estimating purposes, a circular area with a diameter 20 ft greater than the original bermed fire training area will be used for estimating the area of contaminated soil above direct contact criteria. This is a planar area of 8,700 square ft (sq ft). Assuming the depth of the lead above Industrial Direct Contact Values is 1 ft, the resulting volume of contaminated soil would be 320 cu yds. The contaminated area is shown in Figure 2-4.

Several Site 3 soil samples exhibited organic contaminants. Tetrachloroethene (PCE) was detected at depths between 2 and 3.5 ft bgs in soil samples from ESSB-2, ESSB-3, ESSB-4, ESSB-5, and ESSB-6. The detected concentrations of contaminants were in excess of 20 times the Industrial Drinking Water Value, ranging between 124 and 7,800 ug/kg. These soil contaminants occur within the original bermed fire area. ESSB-1 and ESSB-4 are also contaminated at 21 to 26.5 ft bgs by PCE at concentrations over 20 times the Industrial Drinking Water Value. ESSB-1 is located 20 ft downgradient of the bermed fire training area. Additionally, ESSB-4 exhibits a concentration of PCE at 350 ug/kg from 14 to 14.5 ft bgs. This concentration exceeds 20 times the Industrial Drinking Water Value. None of the PCE detections are above the Industrial Direct Contact Values.

Site 3 groundwater has been contaminated by chlorinated hydrocarbons and trimethylbenzene compounds in excess of the Industrial Drinking Water Values. The chlorinated hydrocarbon cis-1,2-dichloroethene (cis-1,2-DCE) is the primary chlorinated compound which was detected in Site 3 groundwater. 1,2-DCE is recognized as a breakdown product of PCE which was detected in the soil. For cost estimating purposes, it is assumed that soil contaminated with chlorinated

SAMPLE 3SB3

| COMPOUND | DETECTED CONC. AT 0 TO 1 ft. | DETECTED CONC. 3 TO 6 ft. | 20 TIMES DRINKING[1] WATER VALUES | DIRECT[2] CONTACT | CALCULATED[3] BACKGROUND |
|---|---|---|---|---|---|
| ANTIMONY | 720 | 150 | 120 | 1.60E+06 | NA |
| BARIUM | 102,000 | NOTE 4 | 40,000 | 3.20E+08 | 76,430 |
| CADMIUM | 8,600 | NOTE 4 | 100 | 2.30E+06 | 1,200 |
| CHROMIUM | 61,900 | NOTE 4 | 2,000 | 1.00E+09 | 18,000 |
| COPPER | 42,200 | NOTE 4 | 80,000 | 1.70E+08 | 32,000 |
| LEAD | 609,000 | NOTE 4 | 80 | 400,000 | 21,000 |
| ZINC | 217,000 | NOTE 4 | 138,000 | 1.00E+09 | 47,000 |

ESSB-2

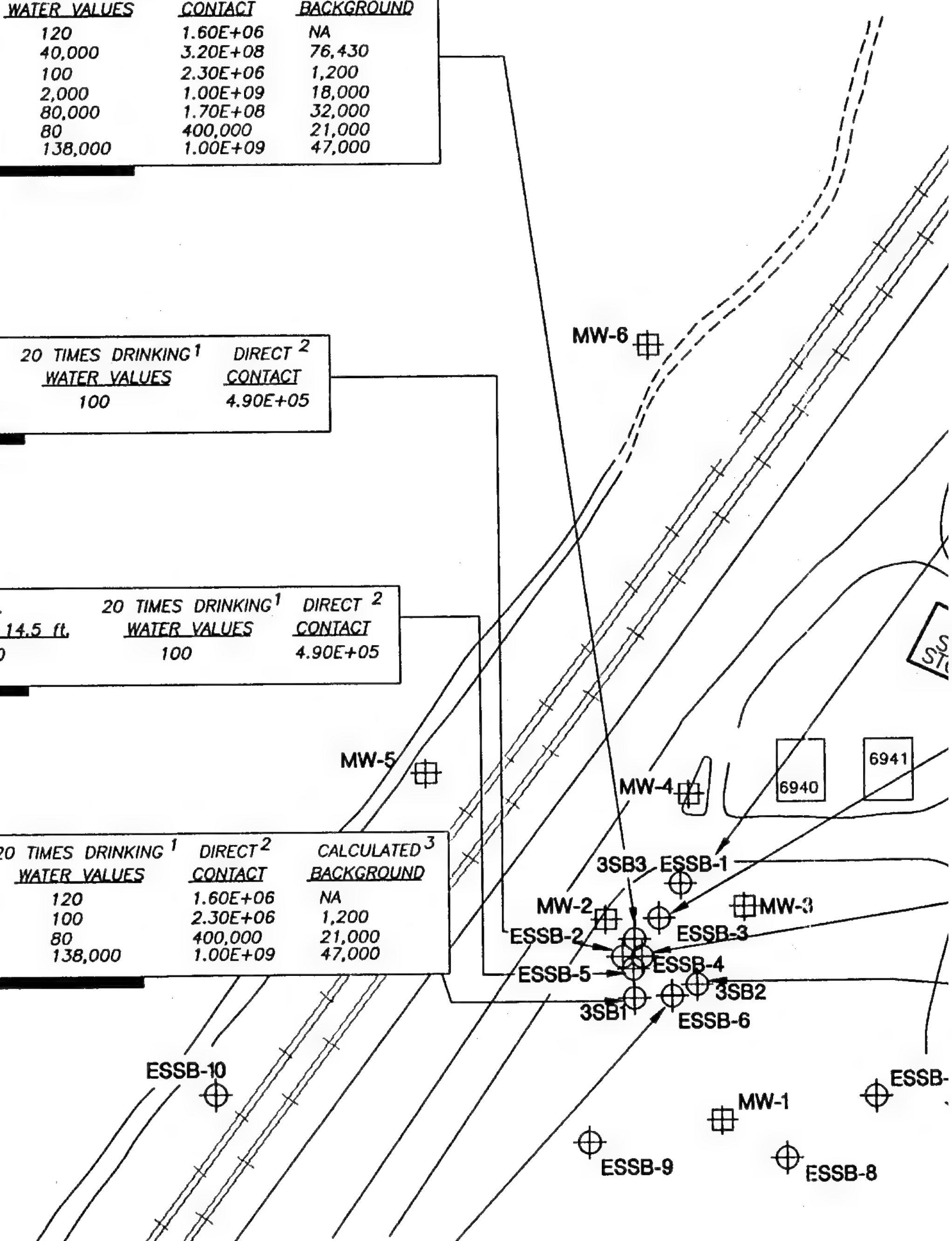
| COMPOUND | DETECTED CONC. AT 2 TO 2.5 ft. | 20 TIMES DRINKING[1] WATER VALUES | DIRECT[2] CONTACT |
|---|---|---|---|
| TETRACHLOROETHENE | 430 | 100 | 4.90E+05 |

ESSB-5

| COMPOUND | DETECTED CONC. AT 2 TO 2.5 ft. | DETECTED CONC. 14 TO 14.5 ft. | 20 TIMES DRINKING[1] WATER VALUES | DIRECT[2] CONTACT |
|---|---|---|---|---|
| TETRACHLOROETHENE | 420 | 260 | 100 | 4.90E+05 |

SAMPLE BC3-SB1

| COMPOUND | DETECTED CONC. AT 0 TO 1 ft. | DETECTED CONC. 3 TO 6 ft. | 20 TIMES DRINKING[1] WATER VALUES | DIRECT[2] CONTACT | CALCULATED[3] BACKGROUND |
|---|---|---|---|---|---|
| ANTIMONY | 140 | 210 | 120 | 1.60E+06 | NA |
| CADMIUM | 2,200 | NOTE 4 | 100 | 2.30E+06 | 1,200 |
| LEAD | 356,000 | NOTE 4 | 80 | 400,000 | 21,000 |
| ZINC | 62,300 | NOTE 4 | 138,000 | 1.00E+09 | 47,000 |




## NOTES:

1. 20 TIMES THE INDUSTRIAL DRINKING WATER VALUE FROM THE GENERIC INDUSTRIAL AND COMMERCIAL CLEANUP CRITERIA MDNR MERA OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN ug/kg.

2. DIRECT CONTACT VALUE FROM THE GENERIC INDUSTRIAL AND COMMERCIAL CLEANUP MDNR MERA OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN ug/kg.

3. CALCULATED BACKGROUND VALUES FROM SOIL SAMPLES TAKEN AT KELLOGG BASED ON MDNR GUIDELINES FOR DETERMINING BACKGROUND VALUES.

4. THIS CONSTITUENT WAS NOT DETECTED AT A CONCENTRATION ABOVE THE CALCULATED BACKGROUND BACKGROUND VALUE OR THE INDUSTRIAL DIRECT CONTACT VALUE.

5. NA INDICATES NOT AVAILABLE.

SAMPLE ESSB-6

| COMPOUND | DETECTED CONC. AT 2 TO 3.5 ft. | DETECTED CONC. 21 TO 21.5 ft. | 27 TO |
|---|---|---|---|
| BENZENE | NOTE 4 | NOTE 4 | 2C |
| 2-METHYLNAPTHALENE | NOTE 4 | 119 | 4,( |
| 1,3,5-TRIMETHYLBENZENE | NOTE 4 | NOTE 4 | 6, |
| 1,2,4-TRIMETHYLBENZENE | NOTE 4 | NOTE 4 | 1C |
| 1,2,3-TRIMETHYLBENZENE | NOTE 4 | NOTE 4 | 5, |
| TETRACHLOROETHENE | 490 | NOTE 4 | |

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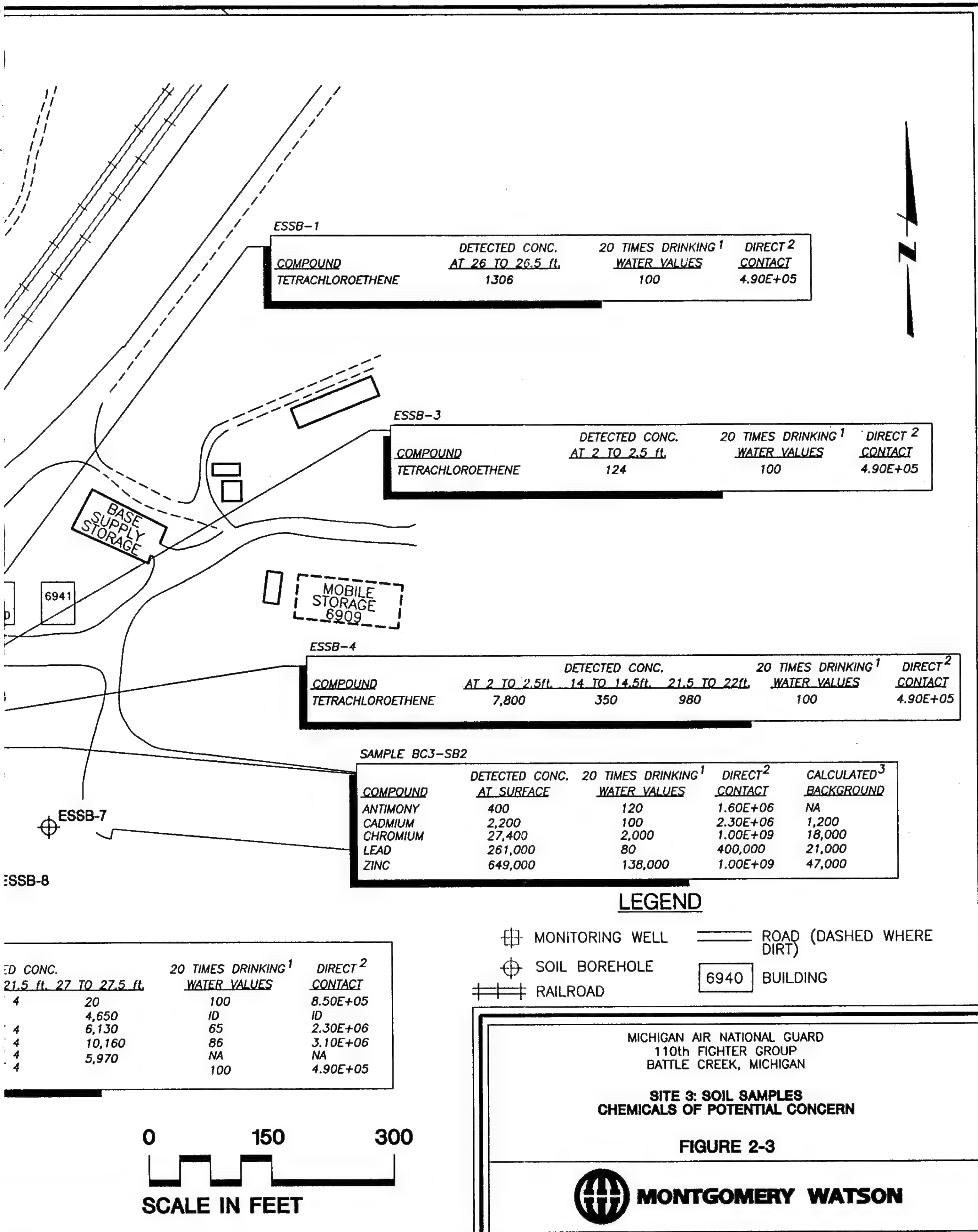


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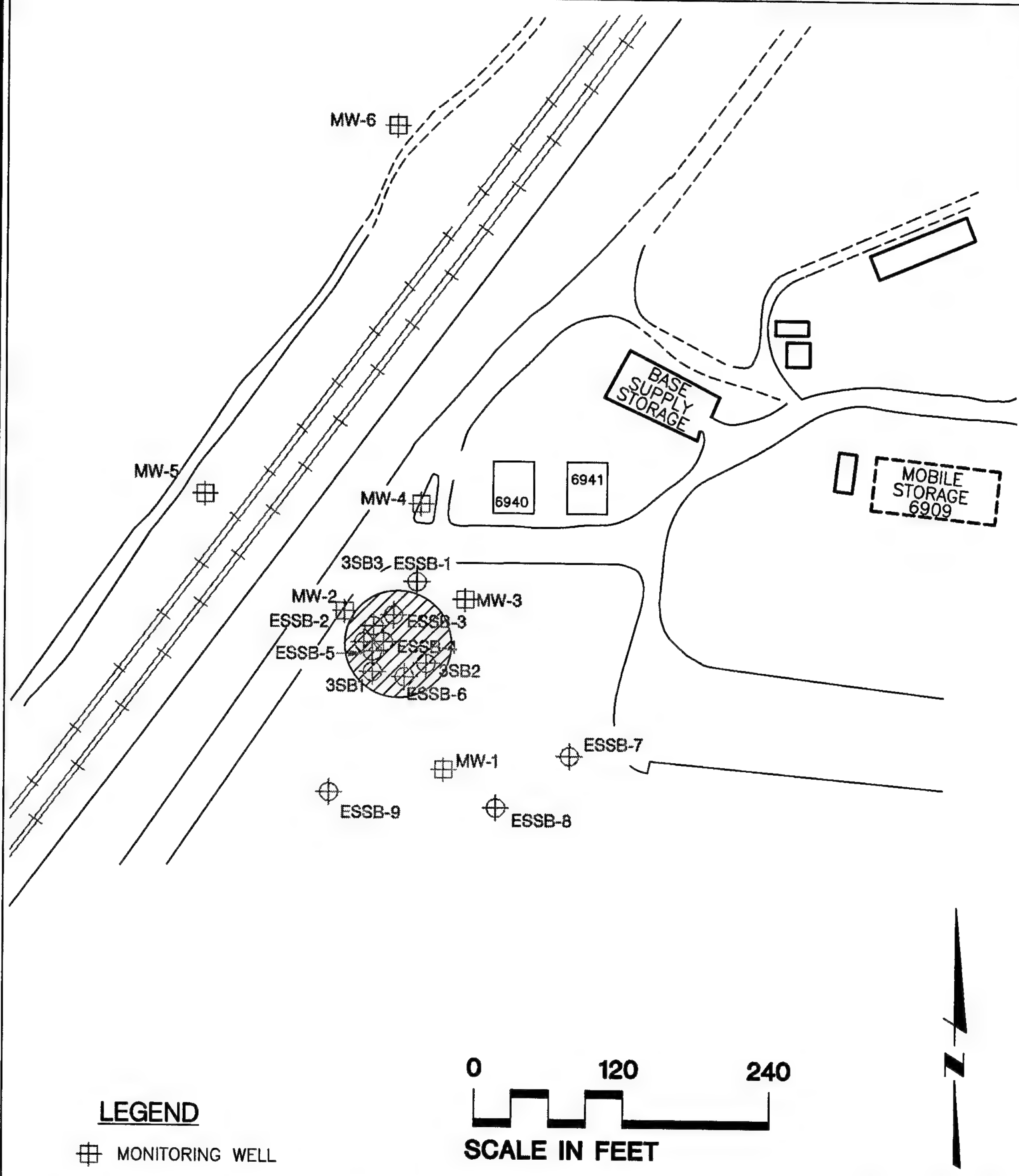
**SITE 3: SOIL SAMPLES**
**CHEMICALS OF POTENTIAL CONCERN**

**FIGURE 2-3**

**MONTGOMERY WATSON**




## LEGEND

- MONITORING WELL
- SOIL BORING MONITORING POINT
- SOIL CONTAMINATED BY LEAD IN EXCESS OF THE INDUSTRIAL DIRECT CONTACT VALUE (ESTIMATED)
- RAILROAD
- ROAD (DASHED WHERE DIRT)
- 6940 BUILDING

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**SITE 3: LEAD CONTAMINATED SOILS IN EXCESS OF THE INDUSTRIAL DIRECT CONTACT VALUE**

**FIGURE 2-4**

**MONTGOMERY WATSON**

hydrocarbons (i.e., PCE) is contained in a circular area 150 ft in diameter, centered on the bermed fire training area. The depth of the soil contamination is assumed to be 30 ft bgs. This results in a volume of 19,650 cu yds of soil. The contaminated area is shown in Figure 2-5.

Soil samples taken at ESSB-6 show organic contaminants in addition to PCE. Trimethylbenzenes were detected in ESSB-6 soil samples at 27 to 27.5 ft. below ground surface. The detected trimethylbenzenes include 1,3,5-trimethylbenzene at 6,130 ug/kg, 1,2,4-trimethylbenzene at 10,160 ug/kg, and 1,2,3-trimethylbenzene at 5,970 ug/kg. The concentrations of 1,3,5-trimethylbenzene and 1,2,4-trimethylbenzene both exceed 20 times the Industrial Drinking Water Values. 1,2,3-trimethylbenzene is not listed in Op Memo #14. Site 3 groundwater contamination include trimethylbenzenes in excess of the Industrial Drinking Water Values. Soils contaminated by trimethylbenzene compounds are assumed to be located in a circular area 40 ft in diameter centered around soil boring ESSB-6. The vertical extent of the contamination has been estimated as 25 to 30 ft bgs, resulting in an estimated contaminated volume of 235 cu yds. The contaminated area is shown in Figure 2-6.

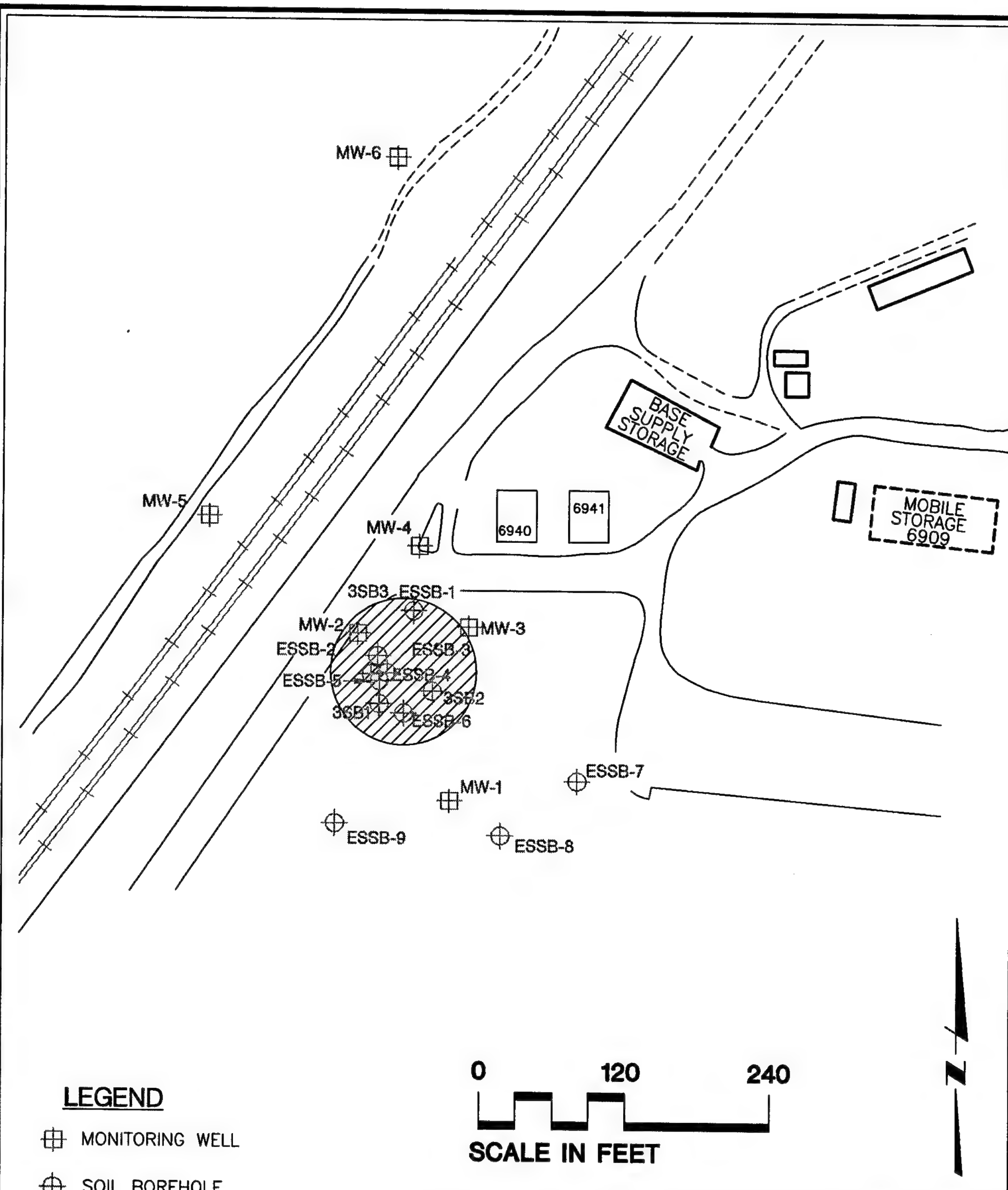
2-methylnaphthalene was detected in soil samples at 21 to 21.5 ft and 27 to 27.5 ft bgs at 119 ug/kg and 4,650 ug/kg respectively. The evaluation criteria for 2-methylnaphthalene in Op Memo #14 are listed as "inadequate data to develop criterion". 2-methylnaphthalene has not been detected in any of the analyzed groundwater samples for the site. 2-methylnaphthalene in soil at Site 3 will not be addressed by this FS Report.

#### 2.4.1.3 Area of Concern A - Waste Accumulation Area.

The summary of contaminants of potential concern in the soil at AOC A is provided in Table 2-1. Based on an evaluation of these contaminants, the following will be addressed by this FS:

- Phenanthrene at concentrations exceeding 20 times the Industrial Drinking Water Value; and
- Metals exceeding Calculated Background Values.

The evaluation of the contaminants of potential concern is provided below.




## LEGEND

- MONITORING WELL
- SOIL BOREHOLE
- SOIL CONTAMINATED BY TETRACHOLOROETHENE IN EXCESS 20 TIMES THE INDUSTRIAL DRINKING WATER VALUE (ESTIMATED)
- RAILROAD
- ROAD (DASHED WHERE DIRT)
- 6940 BUILDING

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**SITE 3: TETRACHLOROETHENE CONTAMINATED SOILS IN EXCESS OF 20 TIMES THE INDUSTRIAL DRINKING WATER VALUE**

**FIGURE 2-5**

**MONTGOMERY WATSON**

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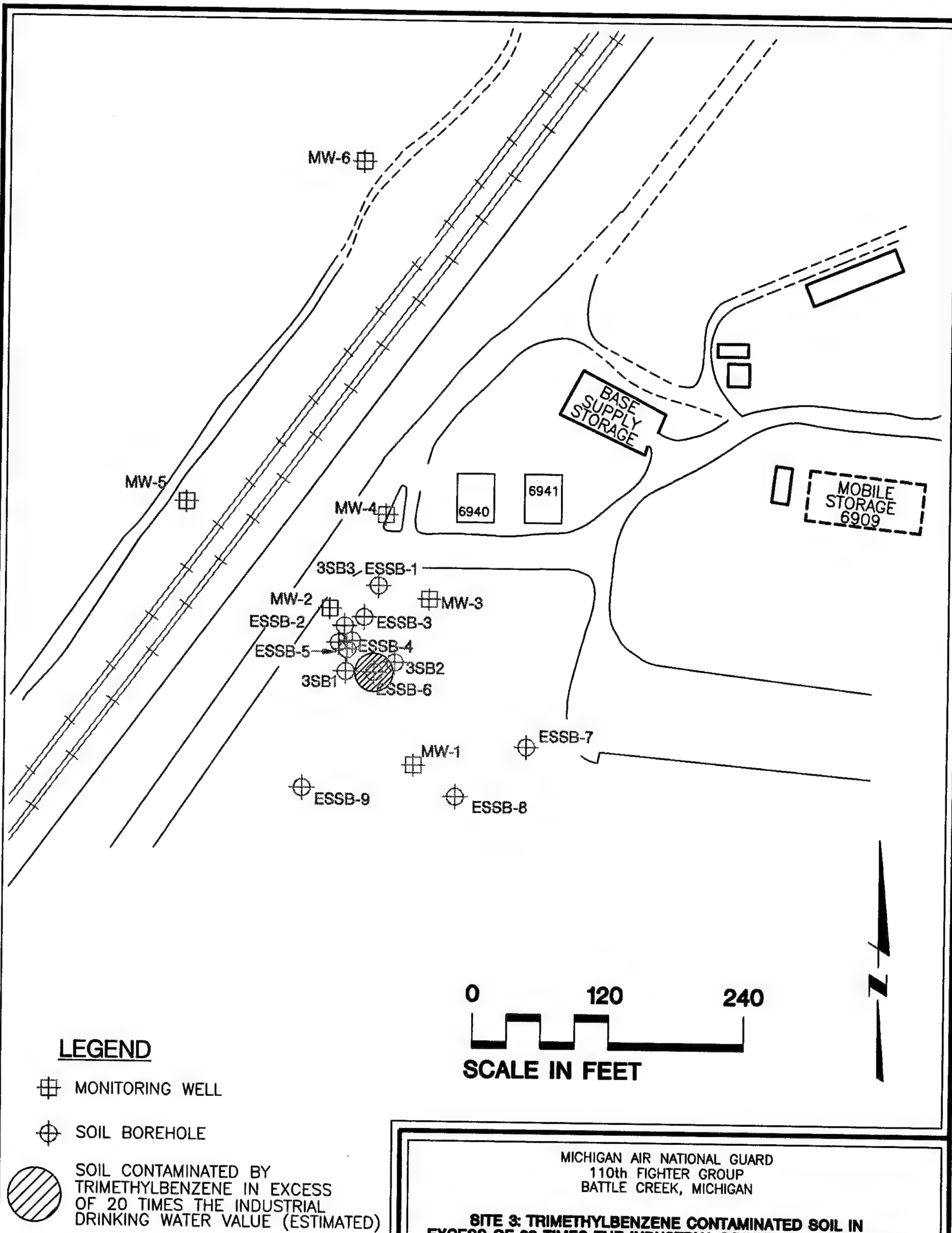


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**SITE 3: TRIMETHYLBENZENE CONTAMINATED SOIL IN EXCESS OF 20 TIMES THE INDUSTRIAL DRINKING WATER VALUE**

**FIGURE 2-6**

**MONTGOMERY WATSON**

Based on information in the 1995 Draft Preliminary Assessment/Site Inspection Report (HAZWRAP, 1995) AOC A appears to have contaminants in the surface soils. All of the surface samples taken at AOC A contained metals at concentrations in excess of the Calculated Background Values. Arsenic was detected in excess of the Calculated Background Value in soil samples ASS02, ASB1, ASS01, and ASB2. Lead was detected at concentrations above the Calculated Background Value in all of the surface soil samples except ASB2. Chromium was detected in the surface soil sample ASB1 at concentrations in excess of the Calculated Background Value. Barium was detected in the surface soil sample ASS02 in concentrations in excess of the Calculated Background Value. Antimony was detected at ASB2 at 3,500 ug/kg. A Calculated Background Value for antimony was not included in the RI Report. Results for location ASB1 at 5 to 7 ft bgs indicated that arsenic, lead and nickel were detected above the Calculated Background Value. None of the soils sampled had inorganic contaminants in excess of the Industrial Direct Contact Value. Figure 2-7 shows contaminants in excess of the Calculated Background Values.

Phenanthrene was detected in most of the surface soil samples. All of the surface soil samples on the north side of AOC A (ASS02, ASB1, ASS01, and ASS03) exhibit concentrations of contaminants in excess of 20 times the Industrial Drinking Water Value. Phenanthrene concentrations range from 1,600 ug/kg to 5,700 ug/kg in surface soil samples. Analysis of subsurface soils at ASB1 detected concentrations of methylene chloride above 20 times the Industrial Drinking Water Value. The sample containing methylene chloride was qualified with a "B" meaning that the blank sample also contained methylene chloride. Methylene chloride is a common laboratory solvent and it is possible that the methylene chloride is attributable to the laboratory and not the soil. No organic soil contaminants exceed the Industrial Direct Contact Values. No groundwater sampling was performed at AOC A. The only way to verify that organic soil contaminants are not leaching to the groundwater is to sample the groundwater and/or perform leach testing. The estimated soil area contaminated by phenanthrene is a rectangle 100 ft by 50 ft with the western edge of the rectangle next to the Civil Engineering building and the northern edge approximately 15 ft south of the road on the north side of AOC A. Based on the data presented in the RI Report, the contaminants are contained within the first foot of soil;

the resulting estimate of contaminated soil is 185 cu yds. The contaminated area is shown in Figure 2-8.

With the exception of antimony, none of the detected inorganic soil contaminants at other sites are detected in excess of the Industrial Drinking Water Values. The only way to verify that soil contaminants are not leaching to the groundwater at AOC A is to sample the groundwater and/or perform leach testing. For cost estimating purposes, the contaminated area is assumed to be a 100 ft by 100 ft rectangle with the western edge next to the Civil Engineering building and the northern edge 15 ft south of the traffic road north of AOC A. It is assumed that soil is contaminated to a depth of 8 ft bgs over half the area and to a depth of 3 ft bgs over the other half. Total estimated inorganic contaminated soil is 2,040 cu yds. The contaminated area is shown in Figure 2-9.

### 2.4.2 GRAs for Groundwater

The GRAs for groundwater with contamination are listed below.

- No Action - Under the no action general response the current state of the groundwater is unchanged.

  Limited Action (Natural Attenuation, Monitoring, Institutional Controls) - The limited action general response is typically enacted to prevent access to or use of contaminated groundwater until cleanup levels are met by natural attenuation and/or treatment.

- Containment - The containment response includes technologies that involve little or no treatment, but provide protection to human health and the environment by reducing the mobility of the contamination to groundwater and preventing human exposure to the contamination.

- In-situ Groundwater Treatment - In-situ groundwater treatment options remediate contaminated groundwater without extraction.

SAMPLE ASS02

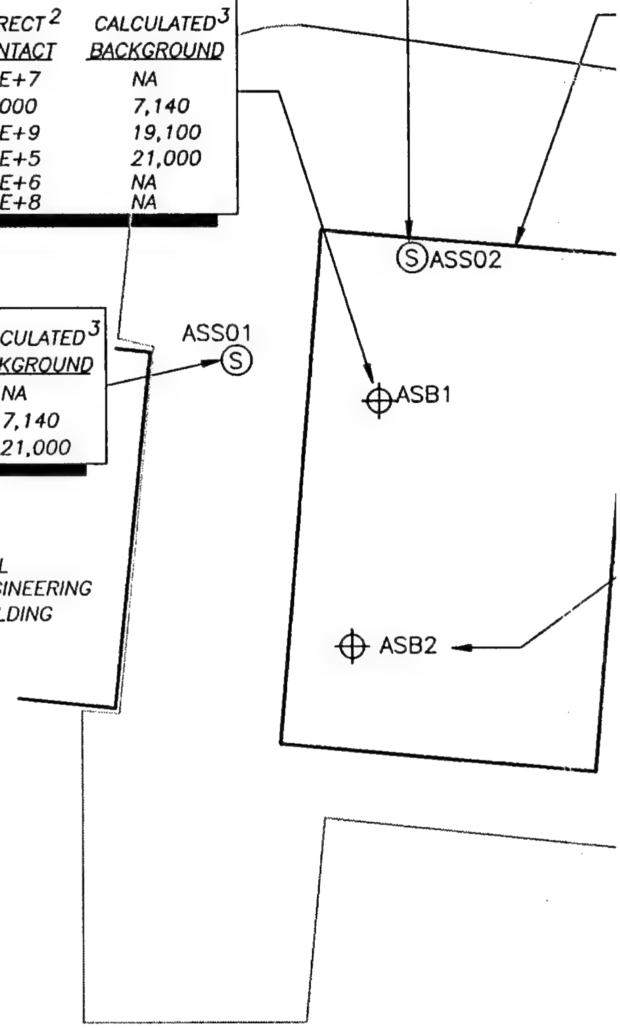
| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 20 TIMES DRINKING[1] WATER VALUES | DIRECT[2] CONTACT | CALCULATED[3] BACKGROUND |
|---|---|---|---|---|
| PHENANTHRENE | 2,800 | 1,500 | 1.6E+7 | NA |
| ARSENIC | 13,800 | 1,000 | 83,000 | 7,140 |
| BARIUM | 76,700 | 40,000 | 3.2E+8 | 76,430 |
| LEAD | 62,000 | 80 | 4.0E+5 | 21,000 |
| ZINC | 53,800 | 138,000 | 1.0E+9 | 47,000 |

SAMPLE ASB1

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 5 TO 7ft. | 20 TIMES DRINKING[1] WATER VALUES | DIRECT[2] CONTACT | CALCULATED[3] BACKGROUND |
|---|---|---|---|---|---|
| PHENANTHRENE | 5,500 | NA | 1,500 | 1.6E+7 | NA |
| ARSENIC | 39,600 | 75,400 | 1,000 | 83,000 | 7,140 |
| CHROMIUM | 23,000 | NA | 2,000 | 1.0E+9 | 19,100 |
| LEAD | 124,000 | 33,000 | 80 | 4.0E+5 | 21,000 |
| METHYLENE CHLORIDE | NA | 180 | 100 | 3.3E+6 | NA |
| NICKEL | NA | 299,000 | 2,000 | 3.4E+8 | NA |

SAMPLE ASS01

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 20 TIMES DRINKING[1] WATER VALUES | DIRECT[2] CONTACT | CALCULATED[3] BACKGROUND |
|---|---|---|---|---|
| PHENANTHRENE | 1,600 | 1,500 | 1.6E+7 | NA |
| ARSENIC | 51,600 | 1,000 | 83,000 | 7,140 |
| LEAD | 58,200 | 80 | 4.0E+5 | 21,000 |




## NOTES:

1. 20 TIMES THE INDUSTRIAL DRINKING WATER VALUE FROM THE GENERIC INDUSTRIAL AND COMMERCIAL CLEANUP CRITERIA MDNR MERA OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN ug/kg.

2. DIRECT CONTACT VALUE FROM THE GENERIC INDUSTRIAL AND COMMERCIAL CLEANUP MDNR MERA OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN ug/kg.

3. CALCULATED BACKGROUND VALUES FROM SOIL SAMPLES AT KELLOGG BASED ON MDNR GUIDELINES FOR DETERMINING BACKGROUND VALUES. CONCENTRATIONS IN ug/kg.

## LEGEND

| | |
|---|---|
| S | SURFACE SOIL SAMPLE LOCATION |
| ⊕ | SOIL BORING |
| NA | NOT AVAILABLE |

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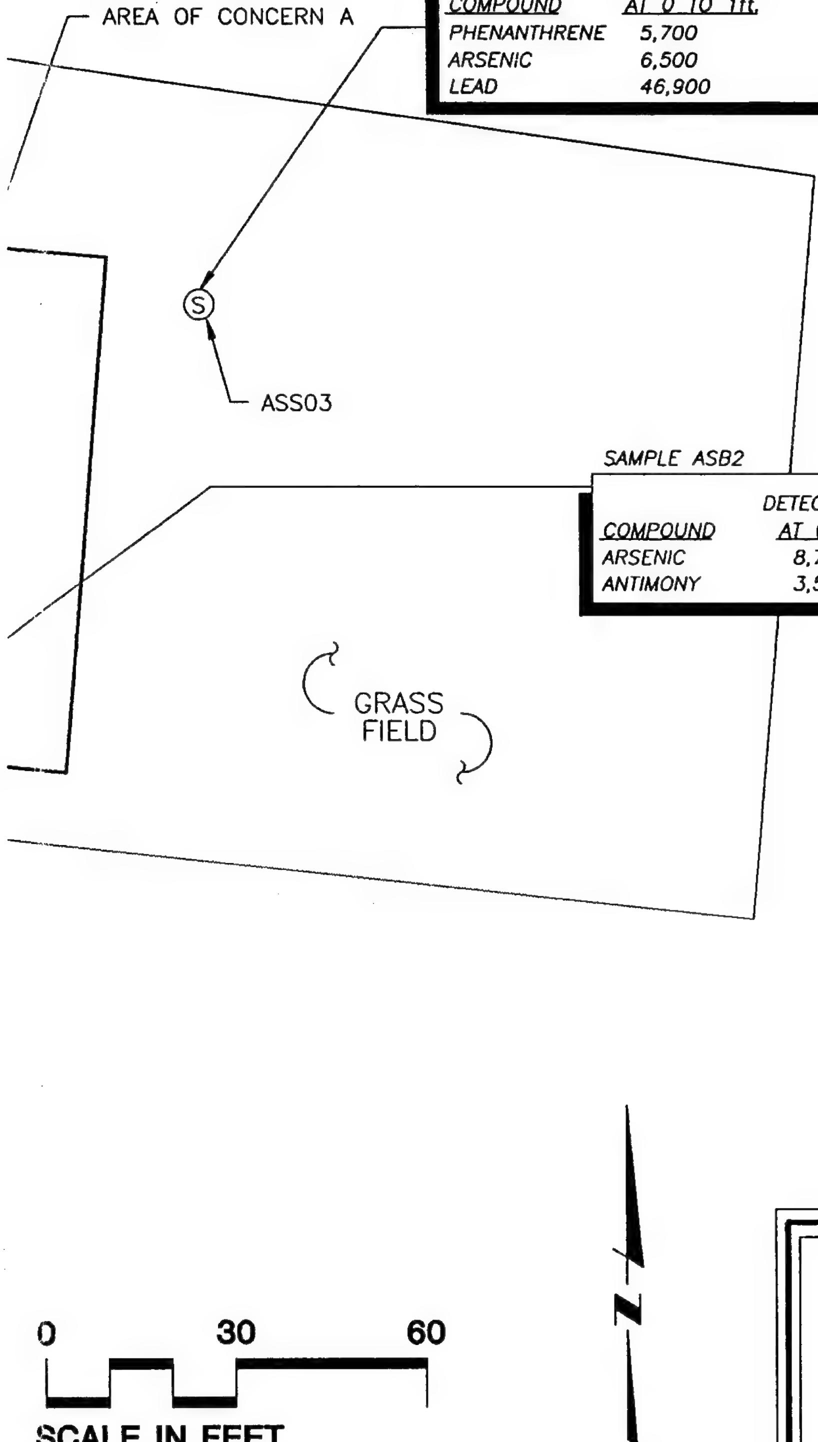
SAMPLE ASS03

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|---|
| PHENANTHRENE | 5,700 | 1,500 | 1.6E+7 | NA |
| ARSENIC | 6,500 | 1,000 | 83,000 | 7,140 |
| LEAD | 46,900 | 80 | 4.0E+5 | 21,000 |

SAMPLE ASB2

| COMPOUND | DETECTED CONC. AT 0 TO 1ft. | 20 TIMES DRINKING WATER VALUES [1] | DIRECT CONTACT [2] | CALCULATED BACKGROUND [3] |
|---|---|---|---|---|
| ARSENIC | 8,700 | 1,000 | 83,000 | 7,140 |
| ANTIMONY | 3,500 | 120 | 1.6E+6 | NA |

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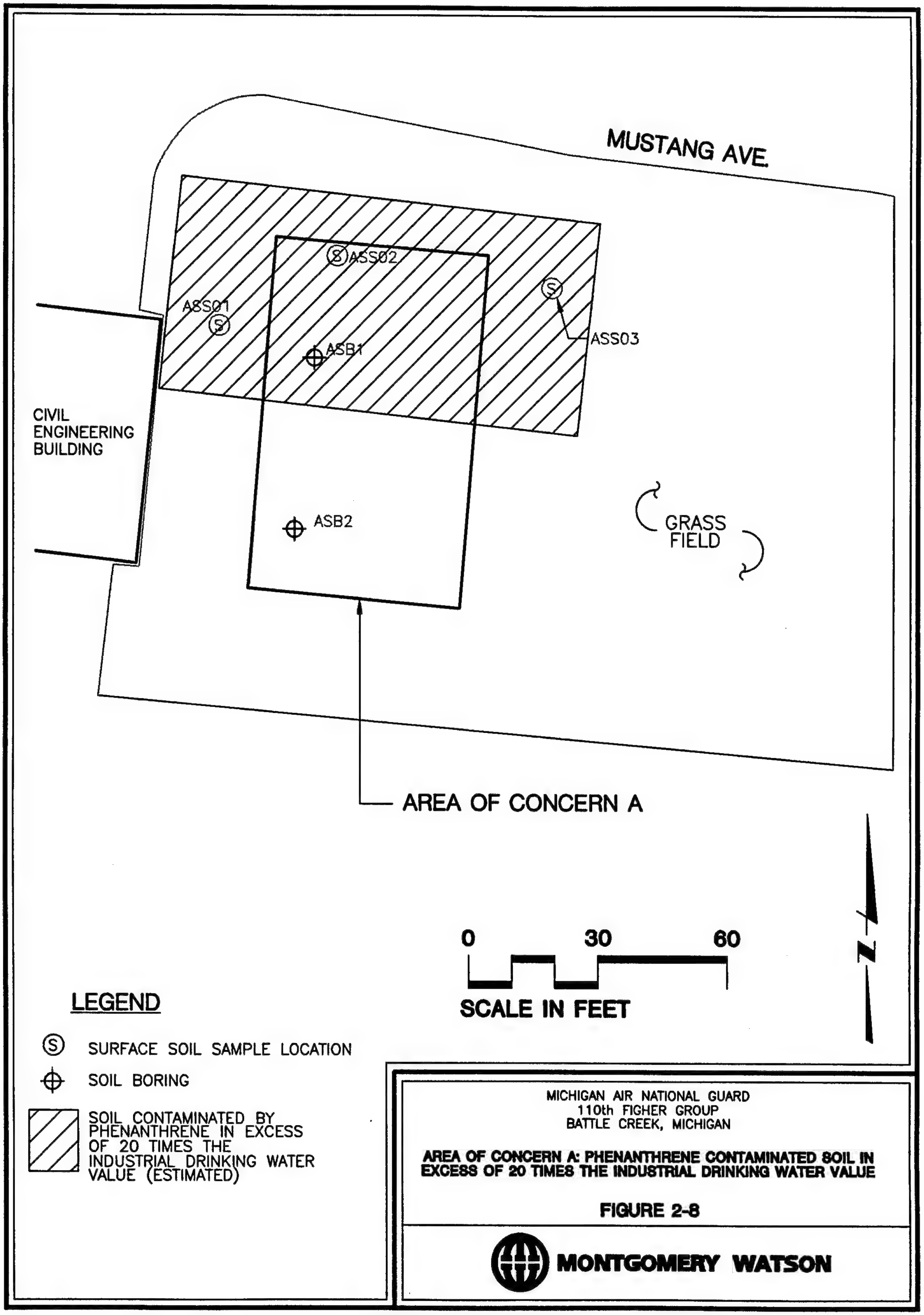
**AREA OF CONCERN A: SOIL SAMPLES CHEMICALS OF POTENTIAL CONCERN**

**FIGURE 2-7**

**MONTGOMERY WATSON**

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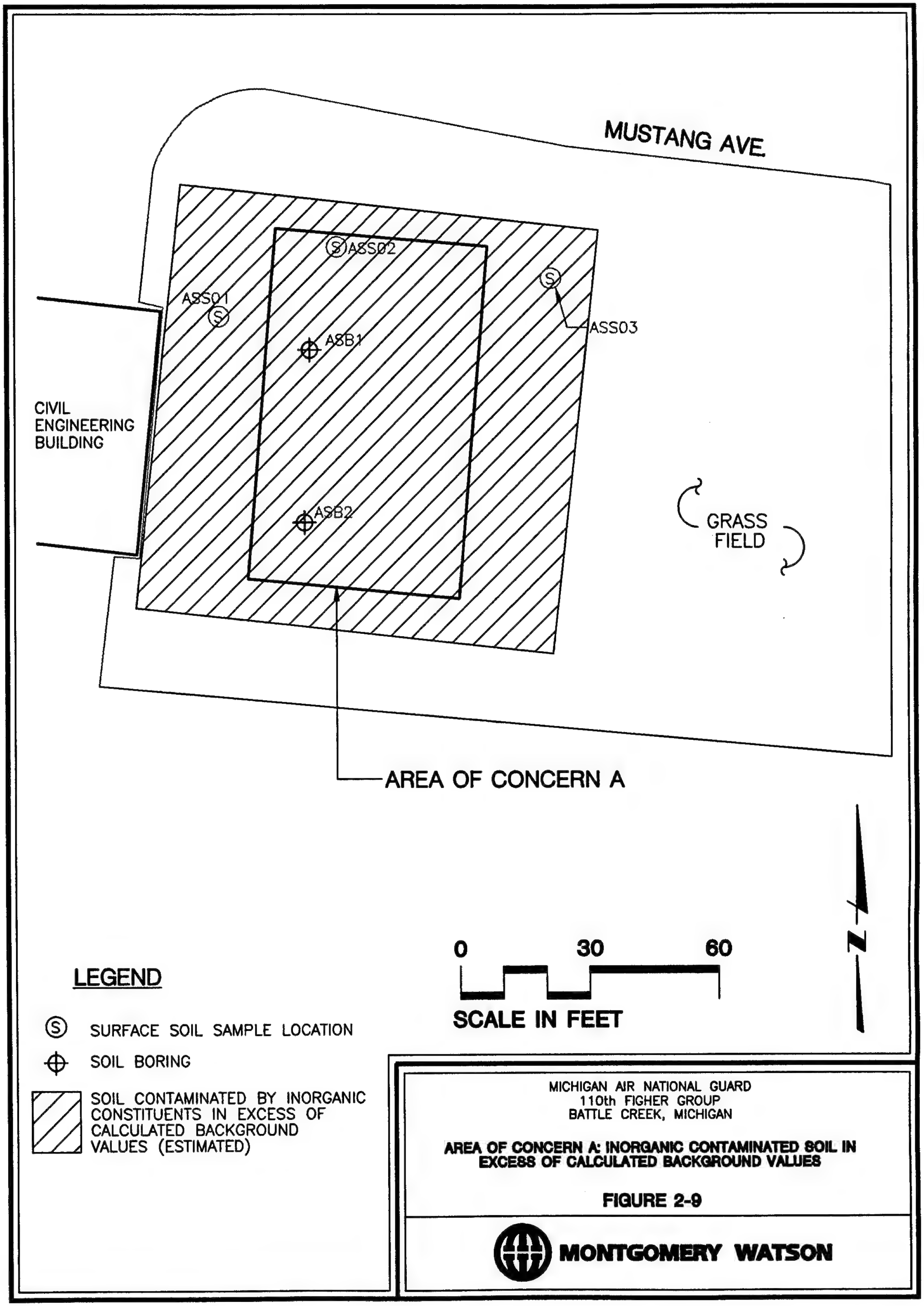
**AREA OF CONCERN A: PHENANTHRENE CONTAMINATED SOIL IN EXCESS OF 20 TIMES THE INDUSTRIAL DRINKING WATER VALUE**

**FIGURE 2-8**


MUSTANG AVE.
ASS02
ASS01
ASS03
ASB1
ASB2
CIVIL
ENGINEERING
BUILDING
GRASS
FIELD
AREA OF CONCERN A
0
30
60
SCALE IN FEET
N
LEGEND
SURFACE SOIL SAMPLE LOCATION
SOIL BORING
SOIL CONTAMINATED BY INORGANIC CONSTITUENTS IN EXCESS OF CALCULATED BACKGROUND VALUES (ESTIMATED)
MICHIGAN AIR NATIONAL GUARD
110th FIGHER GROUP
BATTLE CREEK, MICHIGAN
AREA OF CONCERN A: INORGANIC CONTAMINATED SOIL IN EXCESS OF CALCULATED BACKGROUND VALUES
FIGURE 2-9
MONTGOMERY WATSON

- Aboveground Groundwater Treatment - Under this treatment option, groundwater is extracted and treated aboveground. Treated groundwater is either reinjected, discharged to a publicly owned treatment works (POTW), or disposed in another suitable location.

In evaluating the sites that may require remediation, contaminants detected in the groundwater are compared to Industrial Drinking Water Values, as defined in Op Memo #14.

**2.4.2.1 Site 1 - Fuel Tank Farm and AOC B - Motor Pool Drainage Ditch.**

A summary of contaminants of potential concern in the groundwater at Site 1 and AOC B is provided in Table 2-2. Based on an evaluation of these contaminants, the following will be addressed by this FS:

- Arsenic at concentrations exceeding the Industrial Drinking Water Value;
- Phenanthrene at concentrations exceeding the Industrial Drinking Water Value; and
- PCE at concentrations exceeding the Industrial Drinking Water Value.

The evaluation of the contaminants of potential concern is provided below.

The RI Report indicates that there are both organic and inorganic contaminants in the groundwater at Site 1 and AOC B. The detected contaminants of concern are shown in Figure 2-10. Arsenic was detected in one groundwater sample (BC1-MW2) at a concentration just above the Industrial Drinking Water Value. An estimated area of contaminated groundwater is shown in Figure 2-11. It is estimated that a groundwater pumping system rate of 10 to 30 gallons per minute (gpm) will be necessary to capture the groundwater contaminated by arsenic at this site. This pumping rate is based on hydrogeologic information presented in the RI Report and professional experience in designing groundwater extraction systems at sites with similar hydrogeologic characteristics. The alternatives evaluated at this site for treatment of arsenic will assume a groundwater pumping system with one pump at an estimated rate of 20 gpm.

Iron was detected in the groundwater at one well (BC2-MW1) above the Industrial Drinking Water Value. Iron is a naturally occurring metal that is present in many drinking water supplies. The aquifer below Kellogg is not used for drinking water and there are no plans to use it for

**TABLE 2-2**
**Contaminants of Potential Concern in Groundwater**
**110th Fighter Group**
**Kellogg Memorial Airport**
**Battle Creek, Michigan**

| Groundwater Sample Location | Detected Constituents | Sample Depth (feet) | Detected Concentration (ug/L) | MCL[1] (ug/L) | Industrial Drinking Wat Value[2] (ug/L) |
|---|---|---|---|---|---|
| **SITE 1** | | | | | |
| BC1-MW2 | Arsenic | 20 to 30 | 53.0 | 50 | 50 |
| | | 2 | | | |
| BC2-MW1 | 2-Methylnaphthalene | 25 to 40 | 6 | NA | ID |
| | Iron | 25 to 40 | 430 | 300 | 356 |
| IGW6 | Phenanthrene | 28 to 30 | 880 | NA | 75 |
| IGW10 | Tetrachloroethene | 34 to 36 | 35 | 5 | 5 |
| IGW14 | Tetrachloroethene | 40 to 42 | 5.6 | 5 | 5 |
| **SITE 3** | | | | | |
| BC3-MW1 | Antimony | | 59 | 5 | 6 |
| | bis (2-ethylhexyl) phthalate | | 23 | 4 | 6 |
| BC3-MW2 | 2-Methylnaphthalene | | 8 | NA | ID |
| | Benzene | | 17 | 5 | 5 |
| BC3-MW4 | Antimony | | 58.8 | 5 | 6 |
| ESMP-7S | Benzene | | 12 | 5 | 5 |
| | cis-1,2-dichloroethene | | 125 | 100 | 70 |
| ESMP-15 | Benzene | | 26 | 5 | 5 |
| | 1,3,5-Trimethylbenzene | | 112 | NA | 65 |
| | 1,2,4-Trimethylbenzene | | 223 | NA | 85 |
| | 1,2,3-Trimethylbenzene | | 163 | NA | NA |
| Vent Well | Benzene | | 376 | 5 | 5 |
| | Toluene | | 1,500 | 1,000 | 1,000 |
| | 1,3,5-Trimethylbenzene | | 99 | NA | 65 |
| | 1,2,4-Trimethylbenzene | | 236 | NA | 85 |
| | 1,2,3-Trimethylbenzene | | 188 | NA | NA |
| | cis-1,2-dichloroethene | | 1,410 | 700 | 70 |

Notes:
1) Federal Maximum Contaminant Levels (MCLs) per USEPA Office of Water Drinking Regulations and Health Advisors, under Safe Drinking Water Act (40 CFR Part 141).
2) Industrial Drinking Water Value from Generic Industrial or Commercial Cleanup Criteria and Other Requirements from MDNR Operational Memorandum #14, June 1995.
3) NA idicates that MCL or Industrial Drinking Water Value is not available for this constituent.

SAMPLE BC2-MW1 25 TO 40 ft

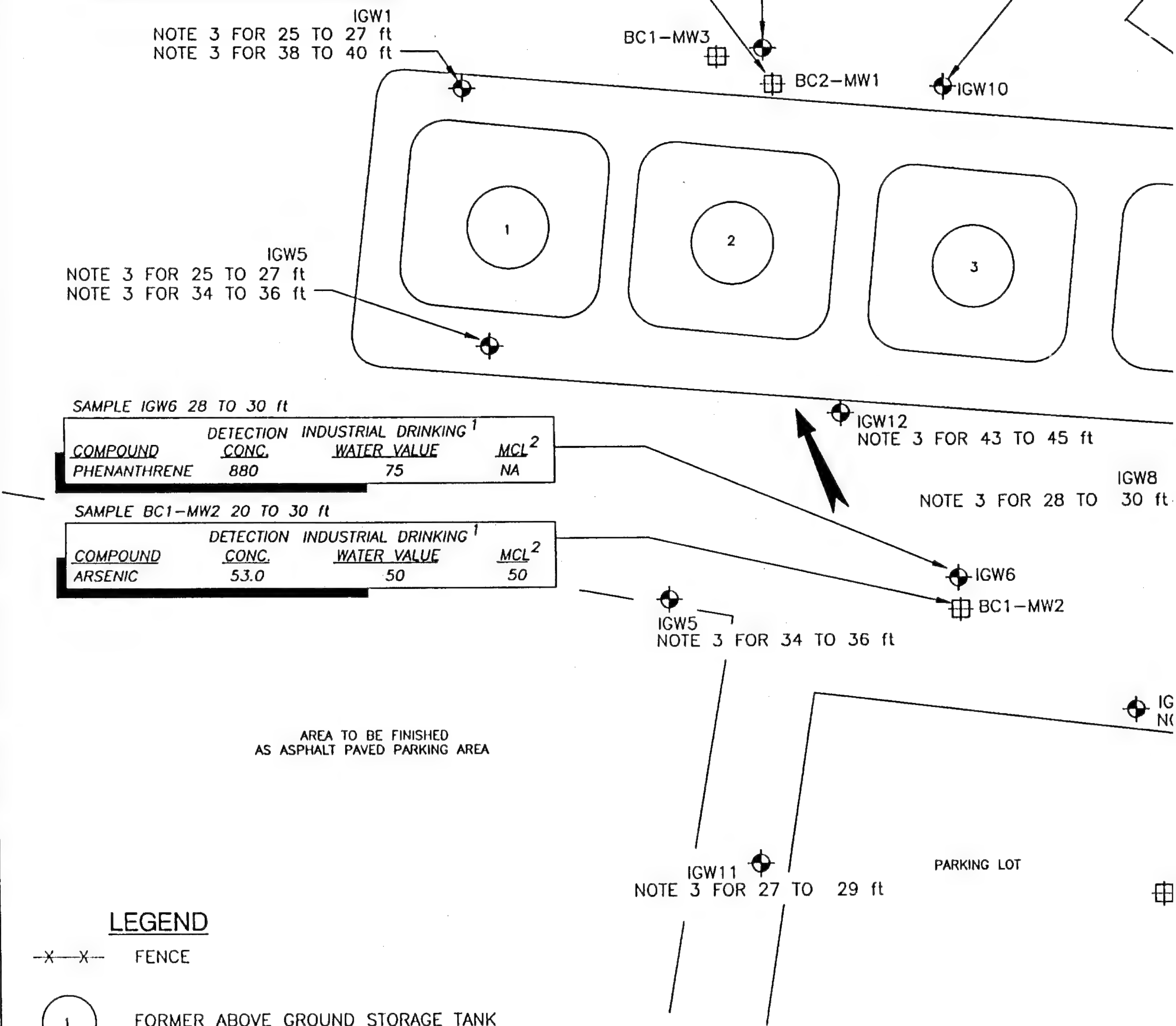
| COMPOUND | DETECTED CONC. | INDUSTRIAL DRINKING WATER VALUE [1] | MCL [2] |
|---|---|---|---|
| 2-METHYLNAPTHALENE | 6 | ID | NA |
| IRON | 430 | 356 | 300 |

SAMPLE IGW6 28 TO 30 ft

| COMPOUND | DETECTION CONC. | INDUSTRIAL DRINKING WATER VALUE [1] | MCL [2] |
|---|---|---|---|
| PHENANTHRENE | 880 | 75 | NA |

SAMPLE BC1-MW2 20 TO 30 ft

| COMPOUND | DETECTION CONC. | INDUSTRIAL DRINKING WATER VALUE [1] | MCL [2] |
|---|---|---|---|
| ARSENIC | 53.0 | 50 | 50 |




## LEGEND

| | |
|---|---|
| -X-X- | FENCE |
| (1) | FORMER ABOVE GROUND STORAGE TANK |
| ⊞ | WATER TABLE MONITORING WELL |
| ⊕ | GROUNDWATER SCREENING LOCATION |
| ➔ | GROUNDWATER FLOW DIRECTION |
| NA | NOT AVAILABLE |

## NOTES:

1. INDUSTRIAL DRINKING WATER VALUE FROM GENERIC IN
COMMERCIAL CLEANUP CRITERIA AND OTHER REQUIREM
MEMORANDUM #14, JUNE 1995. ALL CONCENTRATION
2. MCLS PER USEPA OFFICE OF WATER DRINKING REGUL
HEALTH ADVISORS, MAY 1994. ALL CONCENTRATIONS
3. NO DETECTIONS IN EXCESS OF INDUSTRIAL DRINKING WATER VALUES.

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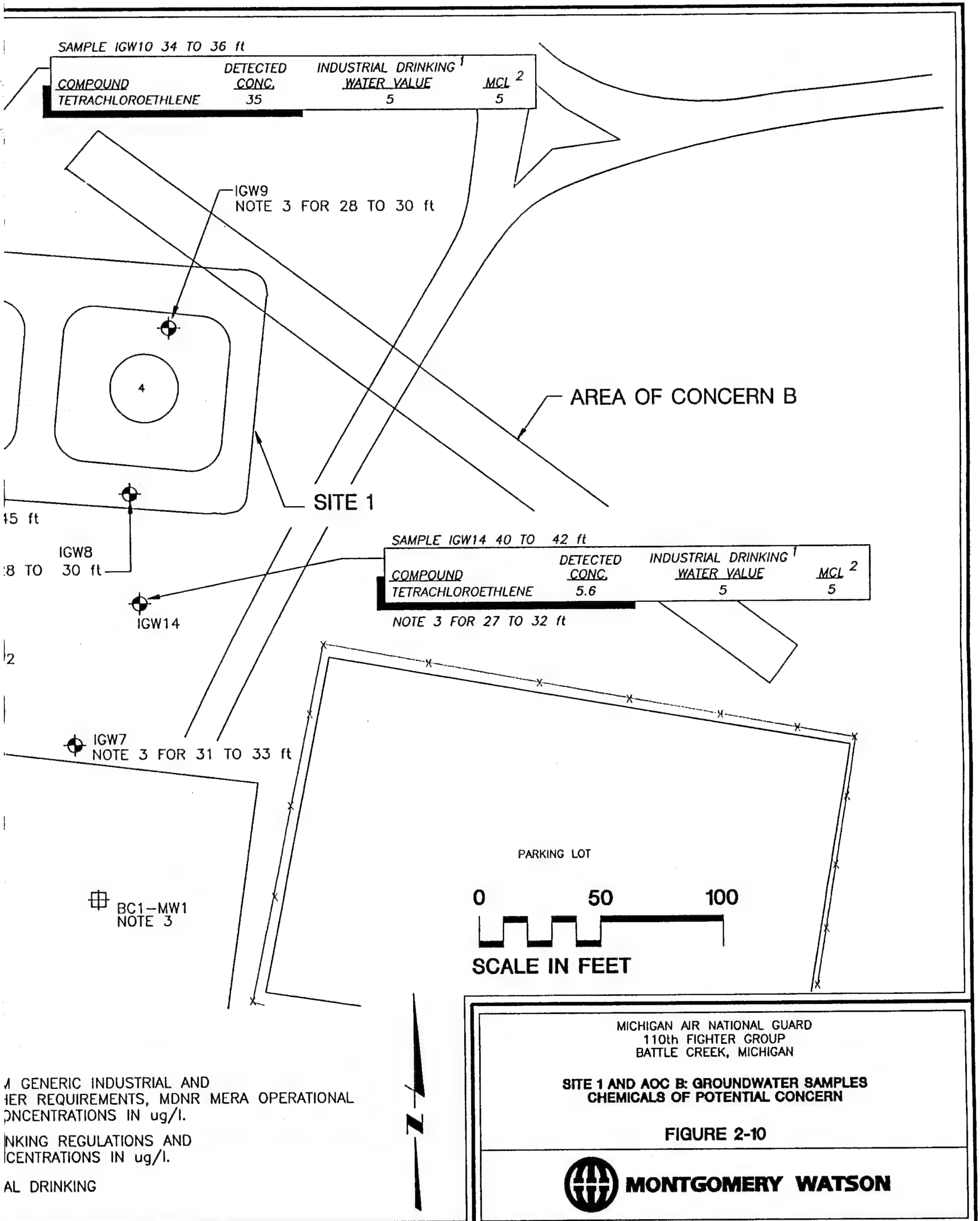
SAMPLE IGW10 34 TO 36 ft
COMPOUND
DETECTED CONC.
INDUSTRIAL DRINKING WATER VALUE 1
MCL 2
TETRACHLOROETHLENE 35 5 5
IGW9
NOTE 3 FOR 28 TO 30 ft
4
AREA OF CONCERN B
SITE 1
45 ft
IGW8
8 TO 30 ft
SAMPLE IGW14 40 TO 42 ft
COMPOUND
DETECTED CONC.
INDUSTRIAL DRINKING WATER VALUE 1
MCL 2
TETRACHLOROETHLENE 5.6 5 5
NOTE 3 FOR 27 TO 32 ft
IGW14
2
IGW7
NOTE 3 FOR 31 TO 33 ft
PARKING LOT
0 50 100
SCALE IN FEET
BC1-MW1
NOTE 3
N
M GENERIC INDUSTRIAL AND
HER REQUIREMENTS, MDNR MERA OPERATIONAL
ONCENTRATIONS IN ug/l.
NKING REGULATIONS AND
CENTRATIONS IN ug/l.
AL DRINKING
MICHIGAN AIR NATIONAL GUARD
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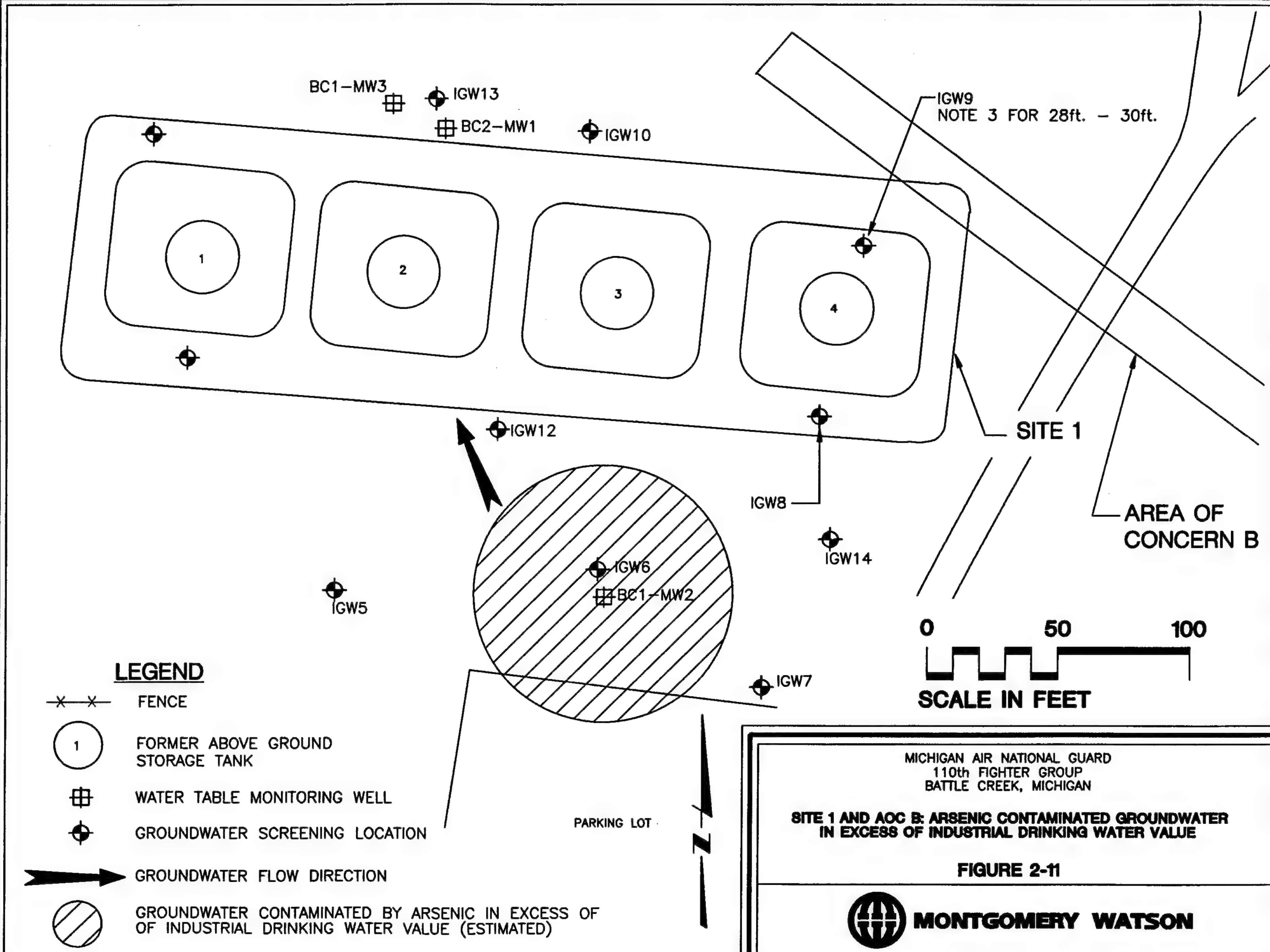
BATTLE CREEK, MICHIGAN
SITE 1 AND AOC B: GROUNDWATER SAMPLES
CHEMICALS OF POTENTIAL CONCERN
FIGURE 2-10
MONTGOMERY WATSON

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BATTLE CREEK, MICHIGAN

**SITE 1 AND AOC B: ARSENIC CONTAMINATED GROUNDWATER IN EXCESS OF INDUSTRIAL DRINKING WATER VALUE**

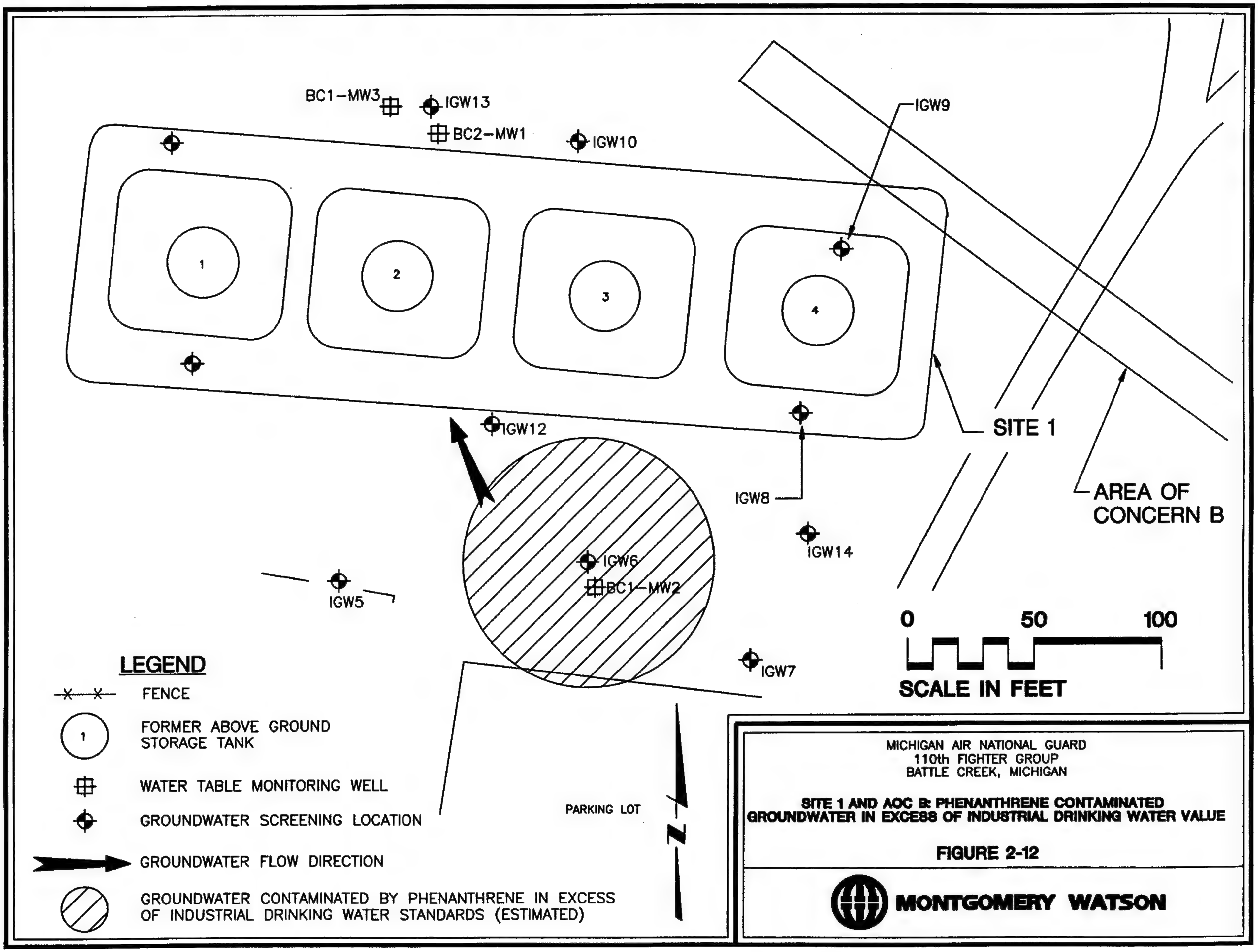
**FIGURE 2-11**

drinking water in the future. Background sampling of groundwater showed elevated levels of iron above both health based drinking water values and aesthetic based drinking water values throughout site groundwater. Additionally, no past operational activities occurred in the area of Site 1 that would account for the elevated iron level in the groundwater. Based on this, remediation of iron in the groundwater will not be considered in this FS.

Organic groundwater contamination includes phenanthrene, PCE, and 2-methylnaphthalene. The 2-methylnaphthalene has no established ARAR as there is inadequate data to develop a cleanup criterion (Op Memo #14). Since no health based criteria have been established and the detected concentrations are not significant, no GRA will be considered for this contamination.

Phenanthrene was detected at concentrations in excess of the Industrial Drinking Water Value in a groundwater sample taken from IGW6. IGW6 is in close proximity to BC1-MW2, the location of the arsenic contamination. The same assumptions will be made regarding the size of the contamination and the pumping rate required for removal of the contamination. The alternatives evaluated at this site for treatment of the organic constituents will assume a groundwater pumping system with one pump at an estimated rate of 20 gpm. Figure 2-12 shows the assumed area contaminated by phenanthrene.

Two locations (IGW14 and IGW10) showed contamination of PCE in the groundwater beneath Site 1 in excess of the Industrial Drinking Water Value. The groundwater sample collected from IGW10 was taken at 34 to 36 ft bgs. IGW14 was sampled at 40 to 42 ft bgs. PCE was not detected 28 to 30 ft bgs at IGW8, which is located between IGW10 and IGW14. It is possible that the PCE detected in IGW14 and IGW10 are in the same plume that is located deeper in the aquifer. The PCE in groundwater at Site 1 was not defined vertically. For cost estimating purposes, it is assumed that the PCE is located between 30 and 50 ft bgs. The assumed area contaminated by PCE is shown in Figure 2-13. Horizontal definition of the PCE contamination was determined by a non-contaminated groundwater sample collected from sample IGW12 between 43 to 45 ft bgs. It is estimated that a groundwater pumping system rate of 10 to 30 gpm will be necessary to capture the groundwater contaminated by PCE at this site. The alternatives

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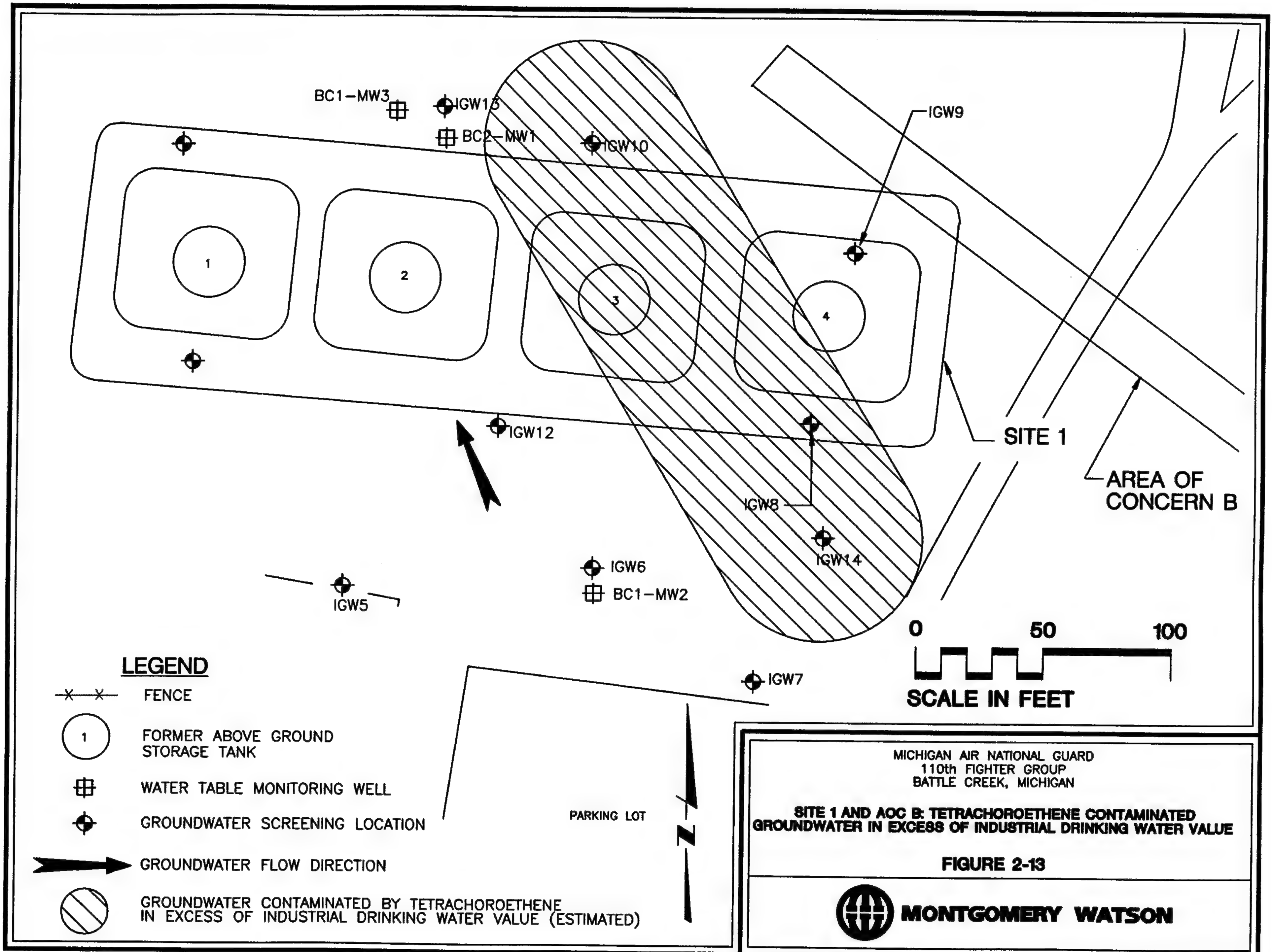
SITE 1 AND AOC B: PHENANTHRENE CONTAMINATED GROUNDWATER IN EXCESS OF INDUSTRIAL DRINKING WATER VALUE

FIGURE 2-12

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**SITE 1 AND AOC B: TETRACHOROETHENE CONTAMINATED GROUNDWATER IN EXCESS OF INDUSTRIAL DRINKING WATER VALUE**

**FIGURE 2-13**

evaluated at this site for treatment of PCE will assume a groundwater pumping system with two to three pumps at an estimated rate of 30 gpm.

**2.4.2.2 Site 3 - Fire Training Area.**

A summary of contaminants of potential concern in the groundwater at Site 3 is provided in Table 2-2. Based on an evaluation of these contaminants, the following will be addressed by this FS:

- cis-1,2-dichloroethene at concentrations exceeding the Industrial Drinking Water Value;
- Benzene at concentrations exceeding the Industrial Drinking Water Value;
- Toluene at concentrations exceeding the Industrial Drinking Water Value; and
- Trimethylbenzenes at concentrations exceeding the Industrial Drinking Water Value.

The evaluation of the contaminants of potential concern is provided below.

Groundwater sampling at Site 3 indicates that groundwater is contaminated by both inorganic and organic constituents. Constituents of concern are shown in Figure 2-14. Antimony was detected in two wells (BC3-MW1 and BC3-MW4) at concentrations above the Industrial Drinking Water Value. Monitoring well BC3-MW1 is located approximately 100 ft upgradient of the bermed fire training area. Monitoring well BC3-MW4 is located approximately 75 ft downgradient of the bermed fire training area. The concentration of antimony in the upgradient well is the same as the concentration in the downgradient well. Since this groundwater is not being used for drinking water, and no source can be shown for the antimony, it will not be considered for remediation.

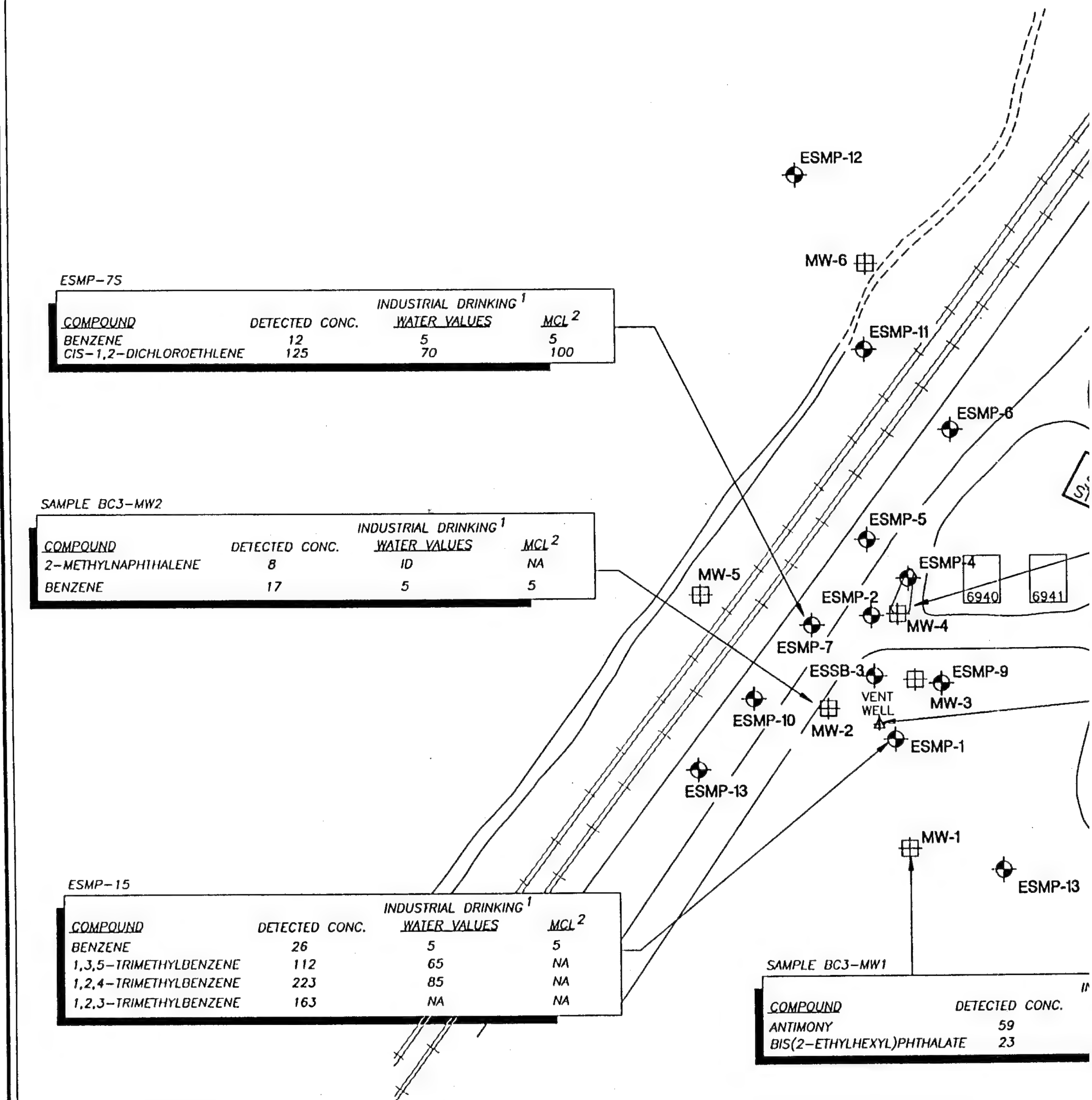
Groundwater sampled in the immediate vicinity and slightly downgradient of the bermed fire training area indicated contamination by cis-1,2-DCE above the Industrial Drinking Water Value. Groundwater samples taken from ESMP-7S and the vent well contain cis-1,2-DCE at concentrations of 125 ug/l and 1,410 ug/l respectively. Groundwater samples BC3-MW2, ESMP-1 and ESMP-7D contain cis-1,2-DCE at values below the Industrial Drinking Water Values. Cis-1,2-DCE was not detected in groundwater samples MW-3, ESMP-2, ESMP-3, ESMP-5, MW-5, ESMP-10, and MW-1. The estimated groundwater area assumed to be contaminated by cis-1,2-DCE is shown in Figure 2-15. The lower limit of the contamination at ESMP-7 is vertically defined at approximately 50 ft bgs by ESMP-7D. It is estimated that a

groundwater pumping system rate of 10 to 30 gpm will be necessary to capture the groundwater contaminated by cis-1,2-DCE at this site. The alternatives evaluated at this site for treatment of cis-1,2-DCE will assume a groundwater pumping system with three pumps at an estimated rate of 30 gpm.

Benzene was detected in excess of Industrial Drinking Water Values in samples taken from the vent well, ESMP-1, ESMP-7S, and BC3-MW2. Toluene was detected at a concentration above the Industrial Drinking Water Value only in the vent well. These contaminants occur in the same wells as cis-1,2-DCE and therefore the contaminated groundwater is considered the same for both cis-1,2-DCE and benzene, as shown in Figure 2-15.

Trimethylbenzene compounds were detected in the vent well and ESMP-1 at concentrations in excess of Industrial Drinking Water Values. Groundwater samples collected from MW-1, MW-3, ESSB-2, and MW-2 did not contain trimethylbenzene compounds. These wells were used to define the horizontal area contaminated with trimethylbenzene. A water sample at ESMP-1 at 50 feet bgs vertically defines the trimethylbenzene. It is estimated that a groundwater pumping system rate of 10 to 30 gpm will be necessary to capture the groundwater contaminated by trimethylbenzene at this site. The alternatives evaluated at this site for treatment of trimethylbenzene will assume a groundwater pumping system with one pump at an estimated rate of 20 gpm. The area contaminated by trimethylbenzene in shown in Figure 2-16.

**2.4.2.3 Area of Concern A - Waste Accumulation Area.** There was no groundwater investigation completed at AOC A.




ESMP-7S

| COMPOUND | DETECTED CONC. | INDUSTRIAL DRINKING WATER VALUES [1] | MCL [2] |
|---|---|---|---|
| BENZENE | 12 | 5 | 5 |
| CIS-1,2-DICHLOROETHLENE | 125 | 70 | 100 |

SAMPLE BC3-MW2

| COMPOUND | DETECTED CONC. | INDUSTRIAL DRINKING WATER VALUES [1] | MCL [2] |
|---|---|---|---|
| 2-METHYLNAPHTHALENE | 8 | ID | NA |
| BENZENE | 17 | 5 | 5 |

ESMP-15

| COMPOUND | DETECTED CONC. | INDUSTRIAL DRINKING WATER VALUES [1] | MCL [2] |
|---|---|---|---|
| BENZENE | 26 | 5 | 5 |
| 1,3,5-TRIMETHYLBENZENE | 112 | 65 | NA |
| 1,2,4-TRIMETHYLBENZENE | 223 | 85 | NA |
| 1,2,3-TRIMETHYLBENZENE | 163 | NA | NA |

SAMPLE BC3-MW1

| COMPOUND | DETECTED CONC. | IN |
|---|---|---|
| ANTIMONY | 59 | |
| BIS(2-ETHYLHEXYL)PHTHALATE | 23 | |

## NOTES:

1. INDUSTRIAL DRINKING WATER VALUE FROM GENERIC INDUSTRIAL AND COMMERCIAL CLEANUP CRITERIA AND OTHER REQUIREMENTS, MDNR MERA OPERATIONAL MEMORANDUM #14, JUNE 1995. ALL CONCENTRATIONS IN ug/l.
2. MCLS PER USEPA OFFICE OF WATER DRINKING REGULATIONS AND HEALTH ADVISORS, MAY 1994. ALL CONCENTRATIONS IN ug/l.

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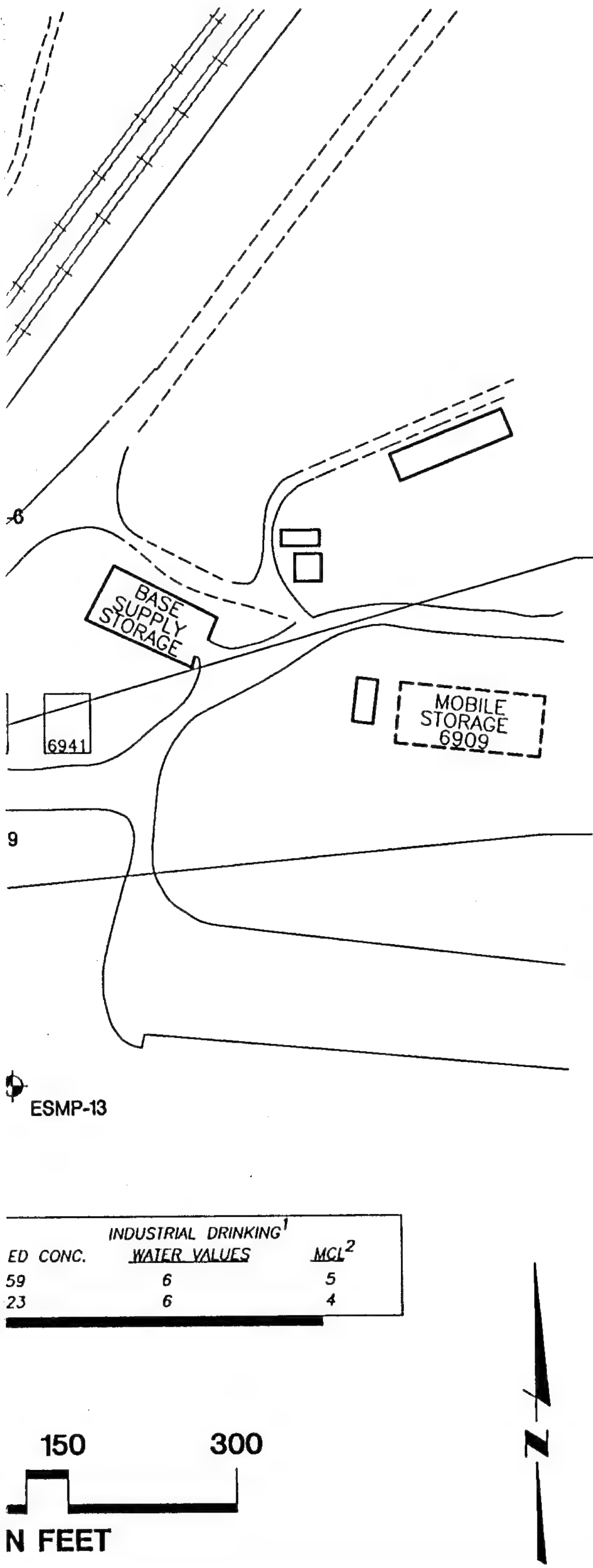


SAMPLE BC3-MW4

| COMPOUND | DETECTED CONC. | INDUSTRIAL DRINKING[1] WATER VALUES | MCL[2] |
|---|---|---|---|
| ANTIMONY | 58.8 | 6 | 5 |

VENT WELL

| COMPOUND | DETECTED CONC. | INDUSTRIAL DRINKING[1] WATER VALUES | MCL[2] |
|---|---|---|---|
| BENZENE | 376 | 5 | 5 |
| TOLUENE | 1,500 | 1,000 | 1,000 |
| 1,3,5-TRIMETHYLBENZENE | 99 | 65 | NA |
| 1,2,4-TRIMETHYLBENZENE | 236 | 85 | NA |
| 1,2,3-TRIMETHYLBENZENE | 188 | NA | NA |
| CIS-1,2 DICHLOROETHENE | 1,410 | 70 | 700 |

| ...ED CONC. | INDUSTRIAL DRINKING[1] WATER VALUES | MCL[2] |
|---|---|---|
| 59 | 6 | 5 |
| 23 | 6 | 4 |

## LEGEND

- MONITORING POINT
- MONITORING WELL
- NA NOT AVAILABLE
- ID INADEQUATE DATA TO DEVELOP CRITERION
- RAILROAD
- ROAD (DASHED WHERE DIRT)
- BUILDING

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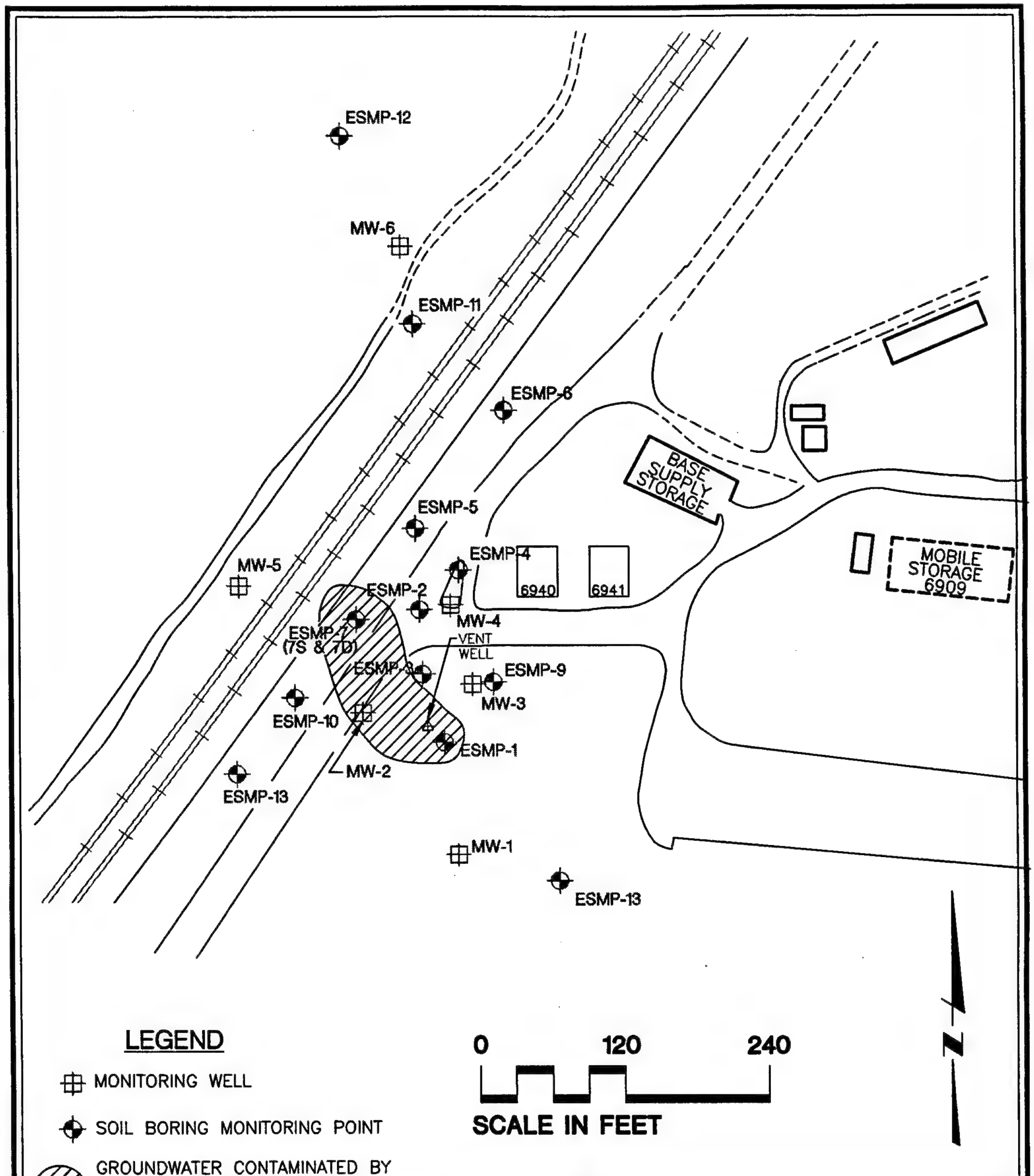
**SITE 3: GROUNDWATER SAMPLES**
**CHEMICALS OF POTENTIAL CONCERN**

**FIGURE 2-14**

**MONTGOMERY WATSON**

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**SITE 3: CIS-1,2-DICHLOROETHENE AND BENZENE CONTAMINATED GROUNDWATER IN EXCESS OF INDUSTRIAL DRINKING WATER VALUES**

**FIGURE 2-15**

**MONTGOMERY WATSON**

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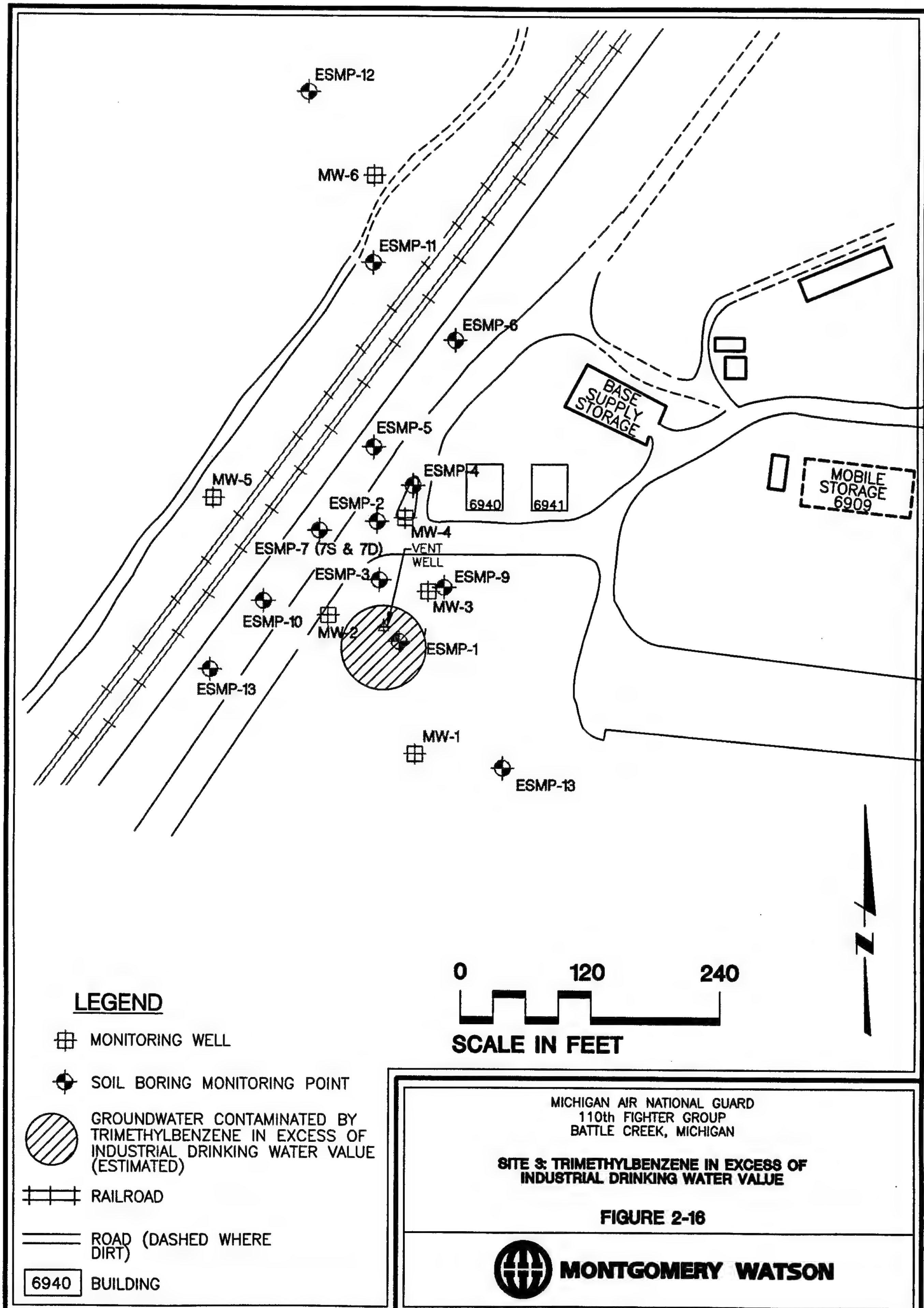


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## 2.5 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

This section discusses the identification and screening of technologies for Kellogg sites. Table 2-3 presents a list of candidate technologies identified for each GRA presented in Section 2.4. The technologies in Table 2-3 are considered applicable for treatment of inorganic and organic contaminants in soil, and inorganic and organic contaminants in groundwater. The technology table was compiled based on professional experience, published sources, and other available documentation. The candidate technologies included under each GRA do not preclude any other technology or response action from future consideration.

In this section, each technology is screened based on effectiveness, implementability, and relative cost. A summary of the general screening of technologies for soil is presented in Table 2-4 and a summary of the general screening of technologies for groundwater is presented in Table 2-5. The tables include columns summarizing the treatment effectiveness, the implementability, the relative cost, the result of the screening, and a brief summary of comments on the screening process.

The following sections provide a discussion of the screening of the technologies identified in Table 2-3, including a presentation of technologies to be used in the formation of the remedial alternatives in Section 3.0.

### 2.5.1 No Action

Under the no action general response action, the current state of groundwater and soil at the site will not be altered. The no action general response action is carried through as a remedial alternative to provide a baseline for comparison with other technologies and process options.

### 2.5.2 Limited Action

The limited action general response action does not directly effect the source of contamination, but serves to prevent human contact with the contamination and monitor the source of the contamination until cleanup levels are met by natural attenuation and/or treatment. Limited actions include institutional controls, monitoring, and natural attenuation.

**TABLE 2-3**
**Remedial Action Objectives, General Response Actions, Technology Types, and Process Options for the Development and Screening of Technologies**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Environmental Media | Contaminant Type | Remedial Action Objectives | General Response Action | Remedial Technology Types | Process Options |
|---|---|---|---|---|---|
| Soils | Inorganic | For Human Health: | No Action: | No Action | NA |
| | | Achieve levels of contaminants in soils that are consistent with cleanup criteria requirements of PA 451, Part 201. | Limited Action: | Institutional Controls<br>Natural Attenuation<br>Monitoring | Fencing, Deed Restriction, Zoning |
| | | Minimize contamination in groundwater caused by contamination in soils. | Containment Actions: | Capping | Single Layer, Multi Layer |
| | | Prevent human health exposure to contaminated soil that could be harmful to health and welfare. | Aboveground Treatment Actions: | Excavation | Solids Excavation |
| | | | | Physical Treatment | Soil Washing |
| | | | | Chemical Treatment | Stabilization/Solidification |
| | | For Environmental Protection: | | Thermal Treatment | Incineration |
| | | Achieve levels of contaminants in soils that are consistent with cleanup criteria requirements of PA 451, Part 201. | In-situ Treatment Actions: | Chemical Treatment | Soil Flushing, Stabilization/Solidification |
| | | | | Thermal Treatment | Vitrification |
| | | Minimize contamination in groundwater caused by contamination in soils | Disposal Actions: | On-site Disposal | On-site Landfill |
| | | | | Off-site Disposal | Off-site commercial Landfill |

**TABLE 2-3 (Continued)**
**Remedial Action Objectives, General Response Actions, Technology Types, and Process Options for the Development and Screening of Technologies**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Environmental Media | Contaminant Type | Remedial Action Objectives | General Response Action | Remedial Technology Types | Process Options |
|---|---|---|---|---|---|
| Soils | Organic | For Human Health: | No Action: | No Action | NA |
| | | Achieve levels of contaminants in soils that are consistent with cleanup criteria requirements of PA 451, Part 201. | Limited Action: | Institutional Controls<br>Natural Attenuation<br>Monitoring | Fencing, Deed Restriction, Zoning |
| | | Minimize contamination in groundwater caused by contamination in soils. | Containment Actions: | Capping | Single Layer, Multi Layer |
| | | Prevent human health exposure to contaminated soil that could be harmful to health and welfare. | Aboveground Treatment Actions: | Excavation | Solids Excavation |
| | | | | Physical Treatment | Enhanced Volatilization, Soil Washing |
| | | | | Chemical Treatment | Stabilization/Solidification |
| | | For Environmental Protection: | | Thermal Treatment | Thermal Desorption, Incineration |
| | | Achieve levels of contaminants in soils that are consistent with cleanup criteria requirements of PA 451, Part 201. | In-situ Treatment Actions: | Physical Treatment | Soil Vapor Extraction |
| | | | | Chemical Treatment | Soil Flushing, Stabilization/Solidification |
| | | | | Thermal Treatment | Vitrification |
| | | Minimize contamination in groundwater caused by contamination in soils | | Biological Treatment | Bio-Venting |
| | | | Disposal Actions: | On-site Disposal | On-site Landfill |
| | | | | Off-site Disposal | Off-site commercial Landfill |

**TABLE 2-3 (Continued)**
**Remedial Action Objectives, General Response Actions, Technology Types, and Process Options for the Development and Screening of Technologies**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Environmental Media | Contaminant Type | Remedial Action Objectives | General Response Action | Remedial Technology Types | Process Options |
|---|---|---|---|---|---|
| Groundwater | Inorganic | For Human Health: | No Action: | No Action | NA |
| | | Achieve levels of contaminants in groundwater consistent with cleanup criteria requirements of Federal MCLs, and PA 451, Part 201. | Limited Action: | Institutional Controls<br>Natural Attenuation<br>Monitoring | Deed Restrictions, Alternate Water Supply |
| | | Prevent human health exposure to contaminated groundwater that could be damaging to human health and welfare. Commission Act of 1929 | Containment Actions: | Horizontal Barriers<br>Vertical Barriers | Grout Injection<br>Slurry Wall, Sheet Piling |
| | | | Aboveground Treatment Actions: | Groundwater collection/extraction | Wells, Subsurface Drains<br>Interceptor Trenches |
| | | | | Physical Treatment | Adsorption, Reverse Osmosis |
| | | For Environmental Protection: | | Chemical Treatment | Ion Exchange, Electro-Chemical |
| | | Achieve levels of contaminants in groundwater consistent with cleanup criteria requirements of Federal MCLs, and PA 451, Part 201. | | Disposal Technologies: | Injection Wells, Storm Sewer System |
| | | | In-situ Treatment Actions: | Physical Treatment | Air Sparging |

**TABLE 2-3 (Continued)**
**Remedial Action Objectives, General Response Actions, Technology Types, and Process Options for the Development and Screening of Technologies**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Environmental Media | Contaminant Type | Remedial Action Objectives | General Response Action | Remedial Technology Types | Process Options |
|---|---|---|---|---|---|
| Groundwater | Organic | For Human Health: | No Action: | No Action | NA |
| | | Achieve levels of contaminants in groundwater consistent with cleanup criteria requirements of Federal MCLs, and PA 451, Part 201. | Limited Action: | Institutional Controls<br>Natural Attenuation | Deed Restrictions, Alternate Water Supply<br>Monitoring |
| | | | Containment Actions: | Horizontal Barriers<br>Vertical Barriers | Grout Injection<br>Slurry Wall, Sheet Piling |
| | | Prevent human health exposure to contaminated groundwater that could be damaging to human health and welfare. Commission Act of 1929 | Aboveground Treatment Actions: | Groundwater collection/extraction | Wells, Subsurface Drains<br>Interceptor Trenches |
| | | | | Physical Treatment | Adsorption, Air Stripping, Reverse Osmosis |
| | | | | Chemical Treatment | Advanced Oxidation |
| | | For Environmental Protection: | | Disposal Technologies: | Injection Wells, Storm Sewer System |
| | | Achieve levels of contaminants in groundwater consistent with cleanup criteria requirements of Federal MCLs, and PA 451, Part 201. | In-situ Treatment Actions: | Physical Treatment | Air Sparging |
| | | | | Chemical Treatment | Chemical Oxidation |
| | | | | Biological Treatment | Bio-Sparging |

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**TABLE 2-4**
**Summary of General Screening of Technologies for Treating Soil**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Technology | Treatment Effectiveness | Implementability | Cost | Result of Initial Screening | Comments |
|---|---|---|---|---|---|
| NO ACTION | | | | | |
| No Action | NA | Easy | None | Consider | Serves as baseline comparison. |
| LIMITED ACTION | | | | | |
| Institutional Controls | NA | Easy | Low | Consider | |
| Monitoring | NA | Easy | Low | Eliminate | |
| Natural Attenuation | NA | Easy | None | Consider | |
| CONTAINMENT | | | | | |
| Capping | NA | Easy | Moderate | Consider | Prevents dermal contact and leaching. |
| IN-SITU SOIL TREATMENT | | | | | |
| Bio-Venting | Moderate | Easy | Low | Consider | Effective for organic contaminants. |
| Stabilization/Solidification | High | Moderate | Moderate | Consider | Effective for preventing leaching of metals. |
| Soil Flushing | Moderate | Difficult | Moderate | Eliminate | Process control difficult/waste stream requires disposal. |
| Vitrification | High | Difficult | Very High | Eliminate | High treatment costs for minor contamination. |
| Soil Vapor Extraction | High | Moderate | Moderate | Consider | Effective for volatile organic contaminants. |
| ABOVEGROUND SOIL TREATMENT | | | | | |
| Stabilization/Solidification | High | Moderate | Moderate | Consider | Effective for preventing leaching of metals. |
| Enhanced Volatilization | Moderate | Moderate | Low | Consider | Primarily for VOCs, less effective on SVOCs. |
| Incineration | High | Difficult | High | Eliminate | High O&M costs. |
| Soil Washing | Moderate | Moderate | Moderate | Eliminate | Produces waste stream requiring disposal. |
| Thermal Desorption | High | Moderate | Moderate | Consider | Effective on organic contaminants. |
| DISPOSAL | | | | | |
| Off-site Disposal | NA | Easy | Moderate | Eliminate | Future liability. |
| On-site Disposal | NA | Moderate | Moderate | Eliminate | No suitable landfill on site. |

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**TABLE 2-5**
**Summary of General Screening of Technologies for Treating Groundwater**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Technology | Treatment effectiveness | Implementability | Cost | Result of Initial Screening | Comments |
|---|---|---|---|---|---|
| NO ACTION | | | | | |
| No Action | NA | Easy | None | Consider | Serves as baseline comparision. |
| INSTITUTIONAL CONTROLS | | | | | |
| Institutional Controls | NA | Easy | Low | Consider | |
| Monitoring | NA | Easy | Low | Consider | |
| Natural Attenuation | NA | Easy | NA | Consider | |
| CONTAINMENT | | | | | |
| Horizontal Barriers | NA | Difficult | Moderate | Eliminate | Unreliable. |
| Vertical Barriers | NA | Moderate | Moderate | Eliminate | No impermeable lower unit. |
| IN-SITU WATER TREATMENT | | | | | |
| Air Sparging | Moderate | Easy | Moderate | Consider | Requires soil vapor extraction. |
| Bio-Sparging | Moderate | Easy | Low | Consider | Only effective for non-halogenated organics. |
| Chemical Oxidation | Moderate | Moderate | Low | Eliminate | Poor process control. |
| ABOVEGROUND WATER TREATMENT | | | | | |
| Adsorption | Moderate | Easy | Low | Consider | Adsorbent must be treated after use. |
| Air Stripping | Moderate | Easy | Low | Consider | May need air permit, highly effective on VOCs. |
| Electro-Chemical | High | Moderate | High | Eliminate | Expensive equipment and operating cost. |
| Ion Exchange | High | Moderate | Moderate | Consider | Effective for metals in low concentrations. |
| Reverse Osmosis | High | Moderate | High | Eliminate | Produces a concentrated waste stream. |
| Advanced Oxidation | High | Moderate | High | Consider | Costly for non-halogenated organics. |
| Precipitation/Flocculation | Moderate | Moderate | Moderate | Eliminate | Better suited to high concentrations of metals. |
| DISPOSAL | | | | | |
| Reinjection/Infiltration | NA | Moderate | Moderate | Consider | Groundwater modeling required. |
| Storm Sewer System | NA | Moderate | Low | Consider | |

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**2.5.2.1 Institutional Controls.** Institutional controls can be implemented to limit human contact with the source of contamination. Institutional controls often include deed restrictions, access restrictions, and land use restrictions.

**2.5.2.1.1 Access Restrictions.** Access restrictions include the construction of security fences that prevent direct contact with contaminated site media and the posting of signs to warn the public of potential health risks. This is effective in keeping the public and animals from coming in contact with the sites containing contamination. Access restrictions, which provide some protection of human health and the environment, are currently in place at Kellogg.

**2.5.2.1.2 Land Use Restrictions.** Land use restrictions prohibit future construction of housing developments, schools, parks, etc., at the site, as well as limit other activities (i.e., vehicular traffic). The limitations for a site are identified based on the risk and exposure pathways present at the site, as well as the remedial actions likely to be implemented. Restrictive covenants, written into the land property deed, notify any potential purchaser of past land use, and restrict land use to ensure the isolation of the area and the integrity of any existing or future waste containment system. The effectiveness of land use restrictions depends on state and local laws, continued enforcement, and maintenance. Most restrictions are subject to changes in political jurisdiction, legal interpretation, and level of enforcement. It is anticipated that some of the Kellogg sites may require restriction of certain activities during and after remedial action operations. For example, a newly-closed, capped site may require protection by restricting subsurface activities and excessive vehicular traffic.

**2.5.2.1.3 Deed Restrictions.** Deed restrictions can be used to prevent construction activities at the site and can be implemented with other technologies at the sites. In some cases deed restrictions can be used to limit exposure to contaminated media until cleanup levels are met. Deed restrictions can also be put in place to prevent use of groundwater at the site.

Institutional controls eliminate pathways between the public and the source of contamination; therefore, this response action is retained for further consideration.

**2.5.2.2 Monitoring.** Groundwater monitoring can be used to track the direction and rate of movement, natural attenuation, and dispersion of groundwater contamination. Groundwater monitoring can be used to evaluate the effectiveness of an alternative if contaminants are left in place. Groundwater is contaminated at some of the Kellogg sites, and one or more alternatives may involve incomplete removal of groundwater contaminants, therefore groundwater monitoring is retained for further consideration.

**2.5.2.3 Natural Attenuation.** Natural attenuation is a process which reduces the concentration of contaminants by diffusion, dilution, microbial degradation, precipitation, or sorption. Natural attenuation is appropriate at sites where the contaminants will safely and naturally attenuate without risk to human health or the environment. Natural attenuation is retained for consideration at the Kellogg sites.

### 2.5.3 Containment Actions

Containment actions seek to isolate the contamination and minimize migration through the use of engineering controls. This section includes the presentation of containment actions for soil followed by the presentation of groundwater containment actions.

**2.5.3.1 Soil Containment Actions.** Containment technologies for soil are those technologies that prevent vertical migration of contaminants through the vadose zone. The containment action considered for soils at the Kellogg sites is capping.

Capping can substantially limit dermal contact with potential human and animal receptors. The cap also minimizes rainwater infiltration through the contaminated soils. Infiltrated rainwater can leach heavy metals and carry organic contaminants into the groundwater. Capping will be retained for consideration at the Kellogg sites.

**2.5.3.2 Groundwater Containment Actions.** Containment technologies for groundwater are those technologies that prevent the migration of contaminants. Vertical barriers are used as

containment technologies for groundwater. Vertical barriers limit the horizontal movement of groundwater. There is no natural low permeability unit located beneath the groundwater. Without a natural low permeability unit for the vertical barriers to tie into, groundwater containment cannot be guaranteed. Horizontal barriers are difficult to install and are not reliable. Vertical and horizontal barriers for groundwater are not retained for further consideration.

### 2.5.4 Treatment Actions

The treatment actions evaluated in this section include technologies for treatment of contaminated soils and groundwater both aboveground and in-situ. This section presents the treatment actions for soils followed by the treatment actions for groundwater.

**2.5.4.1 Soil In-situ Treatment Processes.** The in-situ treatment technologies evaluated for soils include bio-venting, soil flushing, stabilization/solidification, soil vapor extraction, and vitrification. Bio-venting, soil vapor extraction and stabilization/solidification are retained after the screening process.

**2.5.4.1.1 Bio-Venting.** Bio-venting is a treatment process by which enhanced destruction of bio-degradable substances occurs. This is generally accomplished by adding nutrients to the soil. Nutrients can include nitrogen, phosphorous, potassium, oxygen, and carbon. Generally the nutrient limiting biological activity is oxygen. In bio-venting, a blower provides a source of air to a well point located in the area of concern in the unsaturated portion of the soil. The goal is to supply enough air to enhance bio-activity, but not so much as to actively carry volatiles to the surface and into the atmosphere. The area effected by one well is fairly small and large areas may require multiple well points. The cost for this technology is low compared to other treatment technologies for soil. Bio-venting is applicable to organic non-chlorinated substances. Bio-venting is an effective low cost method of treating organic contaminants and is retained for further consideration at sites with non-chlorinated organic contaminants in the soil.

**2.5.4.1.2 Soil Flushing** Soil flushing is a process that uses water or surfactant solutions to extract contaminants from soil. Soil flushing is an in-situ method that mimics the natural

infiltration process. Flushing fluids are introduced into the soil via leach-fields, injection wells, or recharge trenches, and are allowed to percolate through the soil to the water table. The leachate is then extracted via pumping wells, treated, and recirculated. Soil may need several flushing/washing cycles for effective contaminant removal. Soil flushing can be used for either inorganic or organic contamination. Soil flushing is particularly effective when hydraulic controls can be established, but the effectiveness of in-situ soil flushing may be limited by a lack of subsurface process control. The effectiveness of soil flushing is suspect in areas where soils contain high to moderate permeability sands and gravel is inter-layered with low permeability silts and clays. A major disadvantage for treating inorganic contaminants with this technology is the required collection of the solvent and the flushed contaminants for treatment or disposal. In addition, based on the information on the Kellogg sites, control of the soil flushing will be difficult. Therefore, soil flushing will not be retained for further consideration.

**2.5.4.1.3 In-Situ Stabilization/Solidification.** In-situ stabilization/solidification is achieved by a deep soil mixing technique that directly applies solidification agents to the soils to reduce the mobility of contaminants. Mobility is reduced by binding the contaminants into a solidified mass with low permeability that resists leaching. Various agents have been used to enhance binding, such as cement-based, pozzolanic-based, silicate-based, or asphalt-based additives. Solidification technologies have been most widely successful when applied to inorganic wastes. When a highly alkaline solidification agent such as Portland cement is used, an added stabilization effect is gained. Stabilization occurs when the highly alkaline material used for solidification reduces the leachability of the heavy metals. Several vendors use organophilic proprietary compounds as additives to bind organic contaminants to the soil matrix. Bench-scale treatability studies are essential for determining the applicability of the method and for evaluating the choice of parameters, such as effectiveness of solidification agents and other additives, waste-to-additive ratio, and mixing and curing conditions. Disadvantages include the unknown long-term behavior of the solidified mass and the potential limitations on the future uses of the site. Furthermore, continued monitoring of the site may be required because the contamination is left on site. In-situ solidification is readily implemented and requires moderate capital expenditure. Stabilization/solidification will be retained for further consideration at the Kellogg sites.

**2.5.4.1.4 Soil Vapor Extraction.** In-situ Soil Vapor Extraction (SVE) is used to remove volatile contaminants in the unsaturated zone of soils. SVE pulls air from the surface through the unsaturated soils and then collects the air for treatment and discharge. Volatile organic contaminants tend to partition into the air where they are carried out of the soil. SVE uses a blower to pull a vacuum on horizontal or vertical wells placed in unsaturated soil. The collected air is either treated and discharged or simply discharged to the atmosphere. Treatment of the collected air is based on the amount of contaminants in the collected air and the relative quality of the atmospheric air. In the process of getting an air discharge permit a decision will be made to determine the need for treatment. SVE is very effective for volatile organic contaminants in unsaturated soil and will be retained for further consideration.

**2.5.4.1.5 Vitrification.** Vitrification involves melting the contaminated soil in place to bind the waste in a glassy solid matrix resistant to leaching. Organic contaminants in the soil vaporize and are destroyed in the high heat zone directly above the electric heating elements. Costs for this process are high compared to other treatment alternatives for soil. The level of contamination at this site are not high enough to justify the use of this treatment technology. In-situ vitrification is not retained for consideration.

**2.5.4.2 Soil Aboveground Treatment Processes.** The aboveground soil treatment technologies screened include soil washing, thermal desorption, stabilization/solidification, enhanced volatilization, and incineration. Thermal desorption, enhanced volatilization, and stabilization/solidification are retained after the screening process.

The first step in any aboveground treatment technology is the excavation of the contaminated soil. Excavation is a feasible and effective means of removing the source of contamination when the contamination is limited to shallow depths. Monitoring air quality is required during excavation. When fugitive air emissions exceed air quality standards, limitations on the quantity of soil that can be excavated per day may be imposed. However, this should not be of concern at the Kellogg sites, since limited amounts of volatile compounds were detected.

**2.5.4.2.1 Soil Washing.** Soil washing is an aqueous-based technology that generally uses mechanical processes to separate particles that contain contaminants. In this sense it is a volume reduction or pretreatment technology. Soil washing takes advantage of the fact that contaminants generally adhere to the organic carbon and fine-grained soil fraction, such as silt and clay, as opposed to the coarse grained mineral fraction, such as sand and gravel. In addition, contaminants may be removed from the soil by dissolving them in the wash water. Surficial contaminants are removed from the coarse fraction by an abrasive scouring action. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, oxidizer or chelating agent to help remove organic contaminants or heavy metals. Treated soil is cleaned of residual additive contaminants, and the spent wash water is treated to remove the contaminants prior to recycling in the treatment unit. The cost of soil washing is moderate compared to other soil treatment technologies. Soil washing is cost effective when large quantities of soil are being treated. The process is very involved and tends to require a great deal of housekeeping to keep additional areas from becoming contaminated. Residuals from soil washing will still need to be treated and disposed in an off-site facility or possibly recycled through a metal smelter. Off-site disposal is accompanied by liability. Soil washing is not retained for further consideration.

**2.5.4.2.2 Stabilization/Solidification.** Stabilization/solidification is the same process described in Section 2.5.4.1.3 except that the process occurs aboveground. Soils are excavated and then processed (mixed) with agents to fix the contaminants in the soil. Aboveground stabilization/solidification is primarily used for treatment of metals in soils. Once processed, the soils can be returned to the excavation area. Equipment for this treatment system is relatively small and portable and is capable of treating small or large volumes. This technology is retained for consideration at the Kellogg sites.

**2.5.4.2.3 Enhanced Volatilization.** Enhanced volatilization consists of optimizing conditions for volatilization of the VOCs from soils. Soils containing VOCs are excavated and screened to remove large, non-processable materials and debris. Soils are processed through a soil shredder, reducing the soil particle size and volatilizing the VOCs within the soil. The soils

are rescreened and reprocessed as necessary until they meet the required cleanup objectives. The shredder can be hooded and the exhaust directed to an off-gas treatment system. The treatment system can be an adsorption system such as activated carbon or a thermal system such as catalytic oxidation followed by off-gas scrubbing. Enhanced volatilization is inexpensive relative to other treatment technologies for soil, and remediation can be accomplished in a short time frame. This technology is retained for further consideration.

**2.5.4.2.4 Thermal Desorption.** Thermal desorption is a process of contaminant removal which transfers contaminants from one physical state to another. The system operates by targeting an operational temperature at which the contaminants vaporize and become part of the gas stream. This removal mechanism is a physical transfer from the liquid phase to the vapor phase. The gases are removed under negative pressure and routed into a secondary treatment unit where they are further heated and oxidized. The result of this process is a transformation of organic contaminants into primarily carbon dioxide and water. Halogenated hydrocarbons are converted to simple halogenated acids. Thermal desorption is a commonly used technology for the removal of VOCs from soils. Thermal desorption is retained for consideration at Kellogg sites with organic contaminants.

**2.5.4.2.5 Incineration.** Incineration is a process by which combustible materials such as organic contaminants are destroyed and converted to carbon dioxide and water. Any non-combustible material is discharged as ash. These systems run at temperatures between 1400° to 2500° F. Achieving these temperatures requires a great deal of energy. Wastes with a high fuel value lend themselves well to incineration. Based on the information presented in the RI Report, the sites at Kellogg do not have soils with a high fuel value. Incineration has a poor public image and is usually difficult to permit. Due to the poor public image, relatively high cost, and the low fuel value of the soil at the Kellogg site, incineration is not retained for further consideration.

**2.5.4.3 Groundwater In-situ Treatment Processes.** The in-situ treatment technologies evaluated for groundwater include air sparging and chemical oxidation. Air sparging is the only technology retained for further consideration.

**2.5.4.3.2 Chemical Oxidation.** Chemical oxidation consists of pumping oxidants such as hydrogen peroxide or ozone into the groundwater to oxidize contaminants in the groundwater. Oxidants are infiltrated into the groundwater or injected with infiltration wells. Generally, the oxidants do not need to be recovered because their breakdown products, water and oxygen, are harmless. Like soil flushing, the chemical oxidation process lacks subsurface process control. Chemical oxidation is a relatively new process and has not been thoroughly proven. Due to the lack of data on chemical oxidation and the lack of subsurface process control, chemical oxidation is not retained for further analysis.

**2.5.4.3.3 Air Sparging.** Air sparging is a mass transfer process that uses air to actively volatilize VOCs in groundwater into a gas phase. Air is injected directly into the ground using well points. VOCs vaporize into the air bubbles and are carried to the groundwater surface by the natural buoyancy of air. The hydrocarbon laden air is either treated by microbial activity in the vadose zone or allowed to escape to the atmosphere. Depending on the contaminants and the location of nearby buildings, a vapor extraction system may be employed to collect the sparged air. The captured air is sent to off-gas treatment equipment before being released to atmosphere. A side benefit of air sparging is an increase in the biological activity. Less volatile organic contaminants may not respond to air sparging but could be degraded by the increase biological activity that the additional oxygen would promote. Additionally, some inorganic contaminants such as arsenic and lead may precipitate in the presence of oxygen. Air sparging is a proven technology that has been successful in treating VOCs in groundwater at many sites. SVOCs are only mildly effected by air sparging because SVOCs take longer to volatilize than VOCs. Air sparging is retained for further consideration at the Kellogg sites.

**2.5.4.4 Groundwater Aboveground Treatment Processes.** The aboveground technologies for groundwater that were screened include advanced oxidation, precipitation/flocculation, electro-chemical, ion exchange, adsorption, air stripping, and reverse osmosis. Adsorption, air stripping, advanced oxidation, and ion exchange passed the technology screening step.

The first step in an aboveground treatment for groundwater is to extract the groundwater. The groundwater can be extracted with either wells or drains, such as French drains. French drains use horizontal perforated pipes to extract groundwater in the immediate vicinity of the drain. These drains work well when the water level is close to the surface and the subsurface has a low permeability. Wells can be used in either shallow or deep applications and are appropriate for high permeability aquifers. Both French drains and wells will be evaluated for extraction of the groundwater in combination with the treatment technologies listed below for extraction of the groundwater.

**2.5.4.4.1 Advanced Oxidation.** Advanced oxidation processes (AOPs) are defined as those processes generating hydroxyl radicals in sufficient quantity to affect water treatment. Examples of AOPs include ozone/hydrogen peroxide, ozone/ultraviolet (UV) radiation, UV/hydrogen peroxide and ozone/UV/hydrogen peroxide. The advantage of AOPs is that they potentially provide faster, more powerful oxidation than can be achieved by a single oxidant. This allows oxidation of a variety of contaminants which in the past have not been treatable with conventional oxidation processes. AOPs have been shown to successfully treat BTEX and common chlorinated solvents. One advantage of AOPs is that the oxidation process generally produces carbon dioxide, water, and simple organic and halogenated acids. The simple acids are relatively innocuous and the carbon dioxide is highly soluble, therefore no off-gases are produced. AOPs actually destroy the organic contaminants, as opposed to simply removing and storing them. AOPs do not reduce metal concentrations which may be present in the groundwater. Different combination of AOP technologies are often necessary to treat the different properties of contaminants. Each of the AOP technologies involves moderate capital cost. Systems that use UV radiation may have expensive operational costs in addition to the capital cost. AOPs are retained for further consideration at the Kellogg sites.

**2.5.4.4.2 Precipitation/Flocculation.** Precipitation is the process by which a chemical reaction changes a soluble metal ion into a fairly insoluble contaminants. Typical precipitation agents include lime (calcium hydroxide), magnesium hydroxide, and various sulfides. Generally, sulfide precipitates are less soluble and more stable than the hydroxide precipitates. Hydroxide

precipitates can be redissolved by acidification. Flocculation is the process by which small particles of precipitate join together to make a larger particle. These large particles are generally easier to remove from solution than the individual precipitated particles. Flocculation can be encouraged by the addition of various ionic chemicals, such as polymers, which attract the small precipitate particles. Precipitation and flocculation are standard processes for metal removal in the wastewater industry. However, precipitation/flocculation is only a rough removal process. It removes a large quantity of contaminants, but is not able to remove low concentrations of metals in the groundwater. Precipitation/flocculation is not retained for further consideration.

**2.5.4.4.3 Electro-Chemical.** The electro-chemical process can remove heavy metals from groundwater. The process uses a direct current across a consumable, carbon steel electrode to generate an insoluble iron matrix which adsorbs and coprecipitates heavy metals. The insoluble contaminants are separated from the aqueous stream by clarification and dewatering. This process has been shown to be cost-effective for high concentrations of heavy meals in water. At the Kellogg sites, the technology is not cost-effective for the amount of heavy metals present in the groundwater. On the basis of high equipment and operating costs, the electro-chemical process is not retained for further consideration.

**2.5.4.4.4 Ion Exchange.** Ion exchange systems can be used to remove heavy metals from water. An ion exchange system consists of a tank containing small beads of synthetic resin. The beads are treated to selectively adsorb either cations or anions, and exchange ions based on their relative activity compared to the resin. This process of ion exchange continues until all available exchange sites are filled, at which point the resin is exhausted and must be regenerated by suitable chemicals. Ion exchange is capable of reducing metals in water to very low levels. It is expensive to remove large quantities of metals from water with ion exchange. At the Kellogg sites, ion exchange represents a moderate capital expenditure with relatively low operation and maintenance (O&M) cost thereafter. Ion exchange is applicable to the Kellogg sites considering the levels of metals in the groundwater. Ion exchange is retained for further consideration.

**2.5.4.4.5 Adsorption.** Adsorbents such as activated carbon or organophillic clays can be used to remove contaminants from groundwater. The typical adsorption system consists of pumping the contaminated waste stream through one or more adsorbent columns or canisters. When the adsorption unit has exhausted its capacity for adsorption, it is removed and either disposed or regenerated. Contaminants that can be effectively removed by carbon adsorption include VOCs, chlorinated hydrocarbons, poly-chlorinated biphenyls (PCBs), phenols, poly-nuclear aromatic hydrocarbons (PAHs), cyanide, and a few heavy metals. Organo-clays (anthracite mix) are capable of adsorbing oil, VOCs, SVOCs, chlorinated hydrocarbons, and heavy metals. Mixtures of organic contaminants may cause reduced adsorption of a particular contaminant due to the preferential adsorption of the other contaminants. Pilot testing should be performed on the groundwater to be treated to determine the effectiveness of the process. Most of the cost of adsorption is in replacing the spent adsorbent. The amount of adsorbent used is directly proportional to the concentration of the contaminants and the flow rate of water treated. The cost for adsorption at the Kellogg sites should be low relative to other technologies. Adsorption is retained for further consideration.

**2.5.4.4.6 Air Stripping.** Air stripping uses the same principle as air sparging. Clean air is passed through VOC contaminated water where the VOCs volatilize into the air and are carried out of the water. This technology mainly treats VOCs, but can also oxidize certain metals. Chief among these is calcium. Calcium oxidizes to calcium carbonate and crystallizes out on the air inlet ports, often plugging them. High levels of calcium in water usually result in the air stripping equipment requiring frequent maintenance. Water quality data collected during the RI indicate that the hardness (calcium) of the groundwater at Kellogg sites is moderate. Similar to calcium, the presence of iron may cause bio-fouling within the air stripping tower. The presence of metals in the groundwater stream will need to be addressed through routine cleaning and maintenance of the air stripping tower. After the groundwater has been treated with air stripping, the air is contaminated with VOCs. These compounds may need to be treated before the air is released to the atmosphere. Off-gas treatment equipment usually consists of carbon adsorption or catalytic oxidation. Air stripping is retained for further consideration.

**2.5.4.4.7 Reverse Osmosis.** Reverse osmosis is a process which concentrates organic contaminants, salts, and metals while producing a clean water stream. Groundwater is pressurized and passed across a membrane. A portion of the groundwater and compounds with low molecular weights permeate the membrane. The remaining groundwater and other contaminants that do not pass through the membrane are concentrated and then discharged. Reverse osmosis is not a treatment process, but simply reduces the amount of contaminants in the groundwater. Reverse osmosis is a proven technology, but requires costly capital outlay and O&M. Due to the fact that reverse osmosis is very costly and generates a waste stream, it is not retained for further consideration.

### 2.5.5 Disposal Actions

This involves the disposal of soils or groundwater either prior to or after a treatment technology has been completed to reduce and/or eliminate the contamination to the media.

**2.5.5.1 Soil.** The two disposal options that are considered for the excavated soil include on-site disposal and off-site disposal at a landfill. On-site disposal is eliminated from further consideration because there are no adequate landfills at Kellogg. Any off-site disposal of a potentially contaminated soil may have future liability associated with it; therefore, off-site disposal is not retained further consideration.

**2.5.5.2 Groundwater.** Two discharge options were considered for disposal of the treated groundwater.

**2.5.5.2.1 Reinjection.** Reinjection of groundwater can be considered if the returned water meets the drinking water standards and those of Michigan PA 451, Part 31. Reinjection wells are an effective and technically viable means of disposing of the treated groundwater. Reinjection is retained for further consideration.

**2.5.5.2.2 Discharge to Storm Sewer System.** Treated groundwater can be discharged to a storm sewer system currently available at the base. This is a viable means of disposing of treated

groundwater. Measures will need to be taken to ensure that the capacity of the storm sewer system is not exceeded. Disposal to the storm sewer system is retained for further consideration.

## 3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

This section screens media specific alternatives based on effectiveness, implementability, and cost.

### 3.1 APPROACH TO DEVELOPMENT AND SCREENING OF ALTERNATIVES

As previously discussed, the process used in the preparation of this FS has been streamlined by direction of the ANG/CEVR. In an effort to reduce the number of technologies and alternatives screened during the preliminary steps of the FS process, the evaluations in Sections 2.0 and 3.0 of this FS report are performed for media specific categories, rather than by a site specific basis.

The media specific categories evaluated in this section include inorganic contaminants in soil, organic contaminants in soil, inorganic contaminants in groundwater, and organic contaminants in groundwater. These media specific categories are representative of the contaminated media at the Kellogg sites. The technologies retained in Section 2.5 are combined in this section to form alternatives for the four media specific categories. The alternatives passing the screening in this section for each of the media specific categories are combined into site specific alternatives and subjected to a detailed analysis in Section 4.0.

The three criteria used in the screening of the media specific alternatives in this section are defined as follows:

#### 3.1.1 Effectiveness

The effectiveness of the alternative is assessed by evaluating whether the process option is adequate to protect human health and the environment and how quickly the protection is achieved. The evaluation in this section briefly discusses the adequacy of each technology in limiting exposure and protecting human health and the environment (as defined in the RAOs). This criterion also focuses on the compliance with ARARs and the degree to which the process option reduces toxicity, mobility, or volume of impacted media. The alternative is also evaluated to determine if the RAOs are met.

### 3.1.2 Implementability

The implementability of each alternative is evaluated by considering technical feasibility, administrative feasibility, and availability of services and materials. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for the process option until remedial actions are complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies, and the requirements for, and availability of, specific equipment and technical specialties.

### 3.1.3 Relative Cost

The cost of implementing the remedial alternative is the final factor considered in the screening process. Since this section includes a general analysis based on the media specific categories and not on specific sites, no cost figures are presented in this section. The cost analysis in this section is a relative cost comparison of the alternatives presented in this section. Estimated costs are presented in Section 4.0 during the detailed analysis.

## 3.2 SCREENING OF ALTERNATIVES

This section includes the screening of media specific alternatives for Kellogg. The following sections describe in detail the screening of the alternatives.

### 3.2.1 Screening of Alternatives for Soils

For simplicity, this section presents screening of the inorganic and organic soil alternatives separately. This provides sufficient information to determine the most appropriate alternatives to retain for the detailed analysis in Section 4.0. In Section 4.0, the inorganic and organic alternatives retained in this section are combined as needed for complete remediation of the soil at each site.

**3.2.1.1 Inorganic Soil Alternatives.** The alternatives evaluated for the inorganic contaminants in the soil include:

- No Action
- Limited Action - Natural Attenuation, Monitoring, and Institutional Controls

- Containment - Capping
- In-Situ Soil Treatment - Stabilization/Solidification
- Aboveground Soil Treatment - Stabilization/Solidification

Table 3-1 contains a summary of screening completed in this section for the inorganic soil alternatives, including a listing of the alternatives retained for the detailed analysis in Section 4.0. The screening process for each of the alternatives is discussed in detail in the following section.

**3.2.1.1.1 Alternative: No Action.** The no action alternative serves as a baseline for comparison with other remedial alternatives. There are inorganic contaminants at the Kellogg sites over Industrial Direct Contact Values. In addition, there are soil contaminants over Calculated Background Values and 20 times the Industrial Drinking Water Values indicating that contamination at some sites poses a potential threat of leaching to groundwater.

The no action alternative will not include monitoring, containment, or treatment of contaminated soils.

**Effectiveness.** Under the no action option, the toxicity, mobility, and volume of contaminants will not be reduced. Therefore, there is no reduction of contaminant concentrations and no protection of human health or the environment. This alternative will not prevent or reduce leaching of contaminants, if contaminants are leaching. There will be no controls to prevent the use of groundwater at sites that have contaminants that are leaching to the groundwater. This alternative will not meet ARARs or RAOs.

**Implementability.** There will be no actions to implement under this alternative.

**Costs.** There will be no cost associated with the no action alternative.

The no action alternative is retained for further analysis in Section 4.0 to serve as a comparison with other alternatives.

**TABLE 3-1**
**Summary of Screening for Inorganic Contaminants in Soil**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Effectiveness | Implementability | Relative Cost | Screening Result |
|---|---|---|---|---|
| No Action | MTV[a] not reduced.<br>Does not meet ARARs or RAOs. | No action to implement. | No cost | Retained[b] |
| Institutional Controls, Natural Attenuation, and Monitoring | T and V may be reduced (although natural attenuation of metals tends to be ineffective). M will not be reduced.<br>Will not likely meet RAOs or ARARs for protection of human health or the environment. | All actions are technically feasible and easily implemented. | Low cost | Retained |
| Clay, Soil, or Asphalt Capping | T or V not reduced, M is reduced (with certain caps).<br>All caps will provide protection of human health, thus meeting associated RAOs.<br>Certain caps will provide protection of the environment by preventing leaching, thus meeting RAOs.<br>Since the concentrations of the contaminants are not reduced, capping does not meet ARARs. | All actions are technically feasible.<br>Cap can be constructed with conventional equipment and materials. | Low cost | Retained |
| In-Situ Chemical Stabilization/Solidification | T or V not reduced, M is reduced.<br>Provides protection of the environment by reducing leaching of contaminants, thus meeting associated ARARs and RAOs.<br>Will not prevent direct contact with contaminants, thus not meeting RAOs and ARARs for protection of human health at sites with contaminants in excess of Direct Contact Values. | Actions are feasible for the depths of constituents.<br>Treatment can be performed with conventional equipment.<br>Bench scale test required. | Moderate cost | Retained |

**TABLE 3-1 (continued)**
**Summary of Screening for Inorganic Contaminants in Soil**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Effectiveness | Implementability | Relative Cost | Screening Result |
|---|---|---|---|---|
| Aboveground Chemical Stabilization/Solidification | T or V not reduced, M is reduced.<br>Provides protection of the environment by reducing leaching of contaminants, thus meeting associated ARARs and RAOs.<br>Will not prevent direct contact with contaminants, thus not meeting RAOs and ARARs for protection of human health at sites with impacts in excess of Direct Contact Values. | Actions are feasible for the depths of constituents.<br>Treatment can be performed with conventional equipment.<br>Bench scale test required. | Moderate cost (expected to be higher than in-situ treatment).; | Retained |

Notes:
a) M=mobility, T=toxicity, V=volume
b) Under direction of ANG/CEVR, these options will be retained for the detailed analysis.

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**3.2.1.1.2 Alternative: Limited Action - Natural Attenuation, Monitoring, and Institutional Controls.** Under the limited action option the soils are monitored for natural attenuation, but there is no active processing of soil to contain or treat soil contamination. In addition, this alternative includes continued sampling of soil and monitoring of groundwater to assess the natural attenuation process. Depending on the specific site conditions, institutional controls may be necessary to prevent use and prevent human contact with soils until monitoring and sampling shows that appropriate levels have been attained. This alternative will include five-year reviews (CERCLA 121[c]) of the site until monitoring and sampling shows that the contaminant concentrations no longer pose a human health or environmental concern.

**Effectiveness.** This alternative will not involve active reduction of the toxicity, mobility, or volume of soil contamination. If access is restricted, the limited action can effectively prevent human exposure to the contaminants, thus meeting the RAOs for protecting human health. The contaminants in the soil will not be contained and could potentially leach to groundwater, therefore not being protective of the environment and not meeting associated ARARs or RAOs. Past experience has shown that natural attenuation of metals in soil is ineffective. It is not expected that metals will attenuate to appropriate levels. If the soil at a site contains inorganic contaminants above the Industrial Direct Contact Values, this alternative will require extensive use of institutional controls to prevent human contact with contamination.

**Implementability.** All activities required under this alternative are technically feasible. Long-term monitoring of groundwater, sampling of soil, institutional controls, and five-year site reviews can be implemented. It is anticipated that the MIANG can enact and enforce all required institutional controls necessary for this alternative.

**Costs.** The cost for this option will include soil sampling, groundwater monitoring, five-year reviews, and institutional controls. The cost for this alternative is expected to be low relative to treatment costs.

Depending on site specific conditions, the limited action response can provide a cost effective alternative for remediation, and is therefore retained for further analysis.

**3.2.1.1.3 Alternative: Containment - Capping.** This containment alternative includes capping the impacted area. The type of cap will depend on the concerns at the site. A soil or asphalt cap can be used for sites with contamination over Industrial Direct Contact Values to prevent human contact with contamination. A soil or asphalt cap will not be effective in preventing leaching of contamination. For sites with soil contamination that pose a threat of leaching, a clay cap can be implemented to effectively reduce the leaching of soil contaminants. The soil and clay caps will be seeded to prevent erosion of the cap. The cap will be constructed to avoid build up of surface water over the cap. Storm water will be drained to appropriate locations. Institutional controls may be necessary, including construction of a perimeter fence and/or placing use restrictions on the property due to the cap. Monitoring of groundwater may be necessary to assess the performance of the cap, if the intent of the cap is to prevent leaching. Five-year reviews will be completed under this alternative.

**Effectiveness.** Caps will not reduce the toxicity or volume of contaminants in the soil. A clay cap will reduce the mobility of contaminants in the soil by preventing rainwater from infiltrating the soils and leaching the contaminants from the soil to the groundwater. Clay caps will also provide control measures to prevent human access and exposure to the soil contamination. Soil caps will also protect human health by preventing human exposure to contamination, but will not prevent leaching of the soil contamination. Capping will achieve the RAO of protecting human health. A clay cap will meet the RAO associated with minimizing groundwater contamination at sites where leaching is a problem. ARARs will be met with a cap because the migration pathway is minimized. The cap will only be effective if the integrity of the cap is maintained over time.

**Implementability.** Caps have been commonly used in past remedial actions. Caps can be constructed with conventional equipment and materials. Few major difficulties are expected to be encountered during construction of a cap. One issue that can impact the construction of the cap

is the location of structures. Capping can be difficult if the contaminated area is adjacent to immovable structures such as buildings. Monitoring of the groundwater will be necessary to assess the reliability and performance of a cap. It is anticipated that the MIANG can enact and enforce all institutional controls needed to implement this alternative.

**Costs.** The cost for this alternative may include the institutional controls, installation of monitoring wells, contractor mobilization/demobilization, site grading, placement of cap, seeding the cap to reduce erosion, groundwater monitoring, and five-year site reviews. The cost for this alternative is expected to be low to moderate for the Kellogg sites depending on the type of the cap and the area requiring capping.

Capping can effectively prevent rainwater from leaching the inorganic contaminants in the soil to the groundwater, and prevent dermal contact with contamination at a reasonable cost. Capping is retained for further analysis in Section 4.0.

**3.2.1.1.4 Alternative: In-Situ Soil Treatment - Soil Stabilization/Solidification.** This alternative includes solidifying or stabilizing the contaminants in the soil to prevent leaching to the groundwater. Soil stabilization/solidification is accomplished by mixing the contaminated soil with materials that either bind the contaminants or chemically alter the contaminants so that the contaminants are less likely to leach. This can be accomplished insitu by mixing Portland cement, fly ash, or other proprietary materials. Pilot or bench scale tests will be required to determine the additives that will effectively treat the soil contaminants detected at the Kellogg sites.

This alternative is applicable and appropriate for sites which have soil contaminants that pose a threat of leaching to groundwater.. Monitoring wells will need to be sampled to assess the performance of the solidification. Reviews of the sites will be required every five years.

**Effectiveness.** Soil stabilization/solidification has been successfully used in past remedial action. In-situ soil stabilization/solidification binds the metals, effectively reducing the mobility of the inorganic contaminants and protecting groundwater, therefore meeting the associated RAO.

This alternative will not reduce the toxicity or volume of contaminated soils. This alternative will not reduce concentration of the contaminants in the soil nor will it prevent human dermal contact with the soil contamination. Therefore, this alternative will not provide protection of human health at sites with detected contaminants over the Industrial Direct Contact Values. This alternative will not meet human health protection ARARs and RAOs.

**Implementability.** The in-situ solidification can be performed with conventional equipment and materials to depths of the inorganic contaminants at the Kellogg sites. There are no structures at the Kellogg sites and underground obstructions are minimal. Special soil mixers can be used to achieve consistent solidification results as deep as 100 ft bgs.

**Costs.** The cost for this alternative may include contractor mobilization/demobilization, fixation of soils, groundwater monitoring, and five-year site reviews. The cost for this alternative is expected to be moderate compared to other treatment alternatives.

In-situ solidification effectively prevents soil contaminants from leaching to groundwater without significantly limiting future uses of the site. This option is retained for further analysis in Section 4.0.

**3.2.1.1.5 Alternative: Aboveground - Soil Stabilization/Solidification.** This alternative includes excavating soil and treating the soil aboveground to stabilize or solidify the contaminants and prevent leaching to the soils. Soil stabilization/solidification is accomplished by mixing the contaminated soil with materials that either bind the contaminants or chemically alter the contaminants so that they are less likely to leach. Pilot tests may be required to determine the additives that will effectively treat the soil contaminants detected at the Kellogg sites. After the aboveground treatment, the soil will be used to backfill the excavated locations.

This alternative is applicable and appropriate only to sites that have soils leaching contaminants to the groundwater. Monitoring wells will need to be sampled to assess the performance of the solidification. Reviews of the sites will be required every five years.

**Effectiveness.** Soil stabilization/solidification has been commonly and successfully used in past remedial action. Aboveground soil stabilization/solidification binds metals, effectively reducing the mobility of the inorganic contaminants and protecting groundwater therefore meeting the associated RAO. This alternative will not reduce the toxicity or volume of contaminated soils. This alternative will not reduce concentration of the contaminants in the soil nor will it prevent human dermal contact with the soil contaminants. Therefore, this alternative will not provide protection of human health at sites with detected contaminants over the Industrial Direct Contact Values. This alternative will not meet human health protection ARARs and RAOs.

**Implementability.** Aboveground stabilization/solidification allows remediation of soils to all depths that conventional excavation equipment can reach. The aboveground stabilization/solidification is typically used when the soil requires excavation for aboveground treatment of organic contaminants. The excavation and backfilling can be performed with readily available equipment. In addition, equipment is available to mix the soils with the treatment material.

**Costs.** The cost for this alternative may include contractor mobilization/ demobilization, excavation/backfilling, fixation of soils, groundwater monitoring, and five-year site reviews. Aboveground stabilization/ solidification tends to be more expensive than in-situ stabilization/solidification.

This alternative will be retained for consideration at Kellogg sites contaminated with both inorganic and organic contaminants, where the organic contaminants require excavation for treatment.

**3.2.1.2 Organic Soil Alternatives.** The alternatives evaluated for organic contaminants in soil include:

- No Action
- Limited Action - Natural Attenuation, Monitoring, and Institutional Controls
- Containment - Capping

- In-Situ Soil Treatment - Bio-Venting
- In-Situ Soil Treatment - Stabilization/Solidification
- In-Situ Soil Treatment - Vapor Extraction
- Aboveground Soil Treatment - Thermal Desorption
- Aboveground Soil Treatment - Enhanced Volatilization

Table 3-2 contains a summary of screening completed in this section for the organic soil alternatives, including a listing of the alternatives retained for detailed analysis in Section 4.0. The screening process for each of the alternatives is discussed in detail in the following sections.

**3.2.1.2.1 Alternative: No Action.** The no action alternative serves as a baseline for comparison with the remedial alternatives. There are no organic contaminants at the Kellogg sites over Industrial Direct Contact Values. There are however contaminants in the soil at the Kellogg sites over 20 times the Industrial Drinking Water Values indicating that contaminants at some sites have the potential of leaching to groundwater. The no action alternative will not include monitoring, containment, or treatment of contaminated soil.

**Effectiveness.** Under the no action alternative the toxicity, mobility, and volume of the soil contaminants will not be reduced. Therefore, there is no protection of human health and the environment. There will be no controls to prevent the use of groundwater at sites that have contaminants that may be leaching. This alternative will not meet ARARs or RAOs.

**Implementability.** There will be no actions to implement under this alternative.

**Costs.** There will be no cost associated with the no action alternative.

The no action alternative is retained for further analysis.

**TABLE 3-2**
**Summary of Screening for Organic Contaminants in Soil**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Effectiveness | Implementability | Relative Cost | Screening Result |
|---|---|---|---|---|
| No Action | MTV[a] not reduced.<br>Will not meet ARARs or RAOs depending on site specific conditions. | No action to implement. | No cost | Retained[b] |
| Limited Action<br>Institutional Controls, Natural Attenuation, and Monitoring | T and V will be reduced, M is not reduced.<br>Can meet RAOs in long-term.<br>Will provide overall protection of human health and the environment once natural attenuation occurs. Meets ARARs. | All actions are technically feasible and easily implemented. | Low cost | Retained |
| Clay Capping | T and V will not be reduced, M is reduced.<br>Will provide protection of the human health, thus meeting associated RAOs.<br>Will provide protection of the environment by preventing leaching, thus meeting RAOs.<br>Since the concentrations of the contaminants will not be reduced, capping does not meet ARARs. | All actions are technically feasible.<br>The cap can be constructed with conventional equipment and materials. | Moderate cost | Retained |
| In-Situ Soil Treatment<br>Bio-Venting | T and V are reduced, M is not reduced for non-halogenated constituents. This alternative is ineffective on halogenated organic contaminants.<br>Meets ARARs for non-halogenated contaminants.<br>Overall, this alternative will not meet RAOs due to ineffectiveness on halogenated organic contaminants. | All actions are technically feasible.<br>Uses common materials and readily available equipment. | Low to moderate cost | Retained |
| In-Situ Soil Treatment<br>Stabilization/Solidification | T and V not reduced, M is reduced.<br>Treatment not as proven for organic contaminants as inorganic contaminants.<br>Provides protection of the environment by reducing leaching of contaminants, thus meeting associated ARARs and RAOs.<br>Provides protection of human health for the Kellogg site thus meeting RAOs and ARARs. | Organic contaminants are at depths which require more than conventional equipment. This significantly increases the cost of the alternative.<br>Bench scale test required. | Moderate to high cost | Retained |

**TABLE 3-2 (continued)**
**Summary of Screening for Organic Contaminants in Soil**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Effectiveness | Implementability | Relative Cost | Screening Result |
|---|---|---|---|---|
| In-Situ Soil Treatment<br>Soil Vapor Extraction | M and V are reduced, T is not reduced.<br>Provides protection of human health and the environment, thus meeting ARARs and RAOs. | Actions are technically feasible and use common materials and equipment. SVE pilot test required. | Low to moderate cost | Retained |
| Aboveground Soil Treatment<br>Thermal Desorption | MTV reduced.<br>Meets ARARs and RAOs.<br>Provides overall protection of human health and the environment. | All actions are technically feasible. Uses readily available materials and processing equipment. | High Cost | Not retained |
| Aboveground Soil Treatment<br>Enhanced Volatilization | MTV reduced.<br>Meets ARARs and RAOs.<br>Provides overall protection of human health and the environment. | All actions are technically feasible. Uses readily available materials and processing equipment. | Moderate cost | Retained |

Notes:
a) M=mobility, T=toxicity, V=volume
b) Under direction of ANG/CEVR, this option will be retained for the detailed analysis.

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**3.2.1.2.2 Alternative: Limited Action - Natural Attenuation, Monitoring, and Institutional Controls.** Under the limited action alternative, the soil contaminants are not contained or treated, but are monitored for natural attenuation. This alternative will not prevent organic contaminants in the soil from leaching to the groundwater. In addition, this alternative will include monitoring of groundwater to assess any leaching that may be occurring. Institutional controls may be necessary to prevent groundwater use until all leaching ceases from the soil contaminants and groundwater contaminants are at acceptable levels. This alternative will include five-year reviews of the site until monitoring indicates that the site is protective of human health and the environment.

**Effectiveness.** If groundwater use restrictions are used and enforced, the limited action effectively prevents human exposure to organic contaminants in the soil at the sites, thus meeting the RAO of protecting human health. This alternative will not involve active reduction of the toxicity, mobility, or volume of the soil contaminants. The organic contaminants in the soil will not be contained and will have a potential to leach to groundwater, therefore the RAO associated with protection of environment, and associated ARARs will not be met in the short-term. As the contaminants naturally attenuate over time, there will be a reduction in the toxicity and volume of the contaminated soil. In time the reduction of contaminants in the soil will result in the ceasing of leaching of contaminants. The soil RAOs and ARARs will be met in the long-term as the natural attenuation occurs.

**Implementability.** All activities required under this alternative are technically feasible. Long-term monitoring of groundwater, sampling of soil, and five-year site reviews can be implemented. It is anticipated that the MIANG can enact and enforce all required institutional controls needed to implement this alternative.

**Costs.** The cost for this alternative may include soil sampling, groundwater monitoring, five-year reviews, and institutional controls. The cost for this alternative is anticipated to be low compared to treatment options for organic contaminants in soil.

This alternative provides a cost effective means for remediating site contaminants while providing protection of human health. The limited action alternative with natural attenuation is retained for further analysis.

**3.2.1.2.3 Alternative: Containment - Capping.** This containment alternative includes capping the contaminated area. The main concern of the organic contaminants is leaching of the soil contaminants to the groundwater. For sites with soil contaminants that pose a threat of leaching, a clay cap can be implemented to effectively reduce the leaching of soil contaminants. The clay cap will be seeded to prevent erosion of the cap. The cap will be constructed to avoid build up of surface water over the cap. Storm water will be drained to appropriate locations.

The clay cap will only be appropriate for sites with contaminants that are shown to be leaching to the groundwater. Institutional controls may be necessary, including construction of a perimeter fence and/or placing use restrictions on the property due to the cap. Monitoring of groundwater may be necessary to assess the performance of the cap. Five-year reviews will be completed under this alternative.

**Effectiveness.** Caps will not reduce the toxicity or volume of contaminants in the soil. A clay cap will reduce the mobility of contaminants in the soil by preventing rainwater from infiltrating the soils and leaching the contaminants from the soil to the groundwater. Clay caps will also provide control measures to prevent human access and exposure to the soil contaminants. A clay cap will meet the RAO associated with minimizing groundwater contamination at sites with soils that are shown to be leaching contaminants to the groundwater. Since this alternative does not reduce the concentration of the contaminants, the ARARs will not be met. The cap will only be effective if the integrity of the cap is maintained over time.

**Implementability.** Caps have been commonly used in past remedial actions. Caps can be constructed with conventional equipment and materials. Few major difficulties are expected to be encountered during construction of a cap. One issue that can impact the construction of the cap is the location of structures. Capping can be difficult if the contaminated area is adjacent to

immovable structures such as buildings. Monitoring of the groundwater will be necessary to assess the reliability and performance of a cap. It is anticipated that the MIANG can enact and enforce all institutional controls needed to implement this alternative.

**Costs.** The cost for this alternative may include institutional controls, installation of monitoring wells, contractor mobilization/demobilization, site grading, placement of cap, seeding the cap to reduce erosion, groundwater monitoring, and five-year site reviews.

Capping provides a realistic solution to preventing rainwater from leaching the organic contaminants in the soil to groundwater and preventing dermal contact with contaminants at a reasonable cost. Capping is retained for further analysis in Section 4.0.

**3.2.1.2.4 Alternative: In-Situ Soil Treatment - Bio-Venting.** The bio-venting alternative uses a network of shallow wells in the vadose (unsaturated) zone to inject air at a rate suitable to enhance bio-degradation, but not high enough to cause active volatilization. The aerobic bio-degradation process will destroy non-halogenated organic contaminants over a period of time. This alternative can be used for sites which have soil contaminants that pose a threat of leaching to groundwater. Sampling of the soil during the treatment process will be necessary to monitor the contaminants as they degrade. Groundwater will be monitored for sites with soil contaminants that are leaching to assess contaminant concentrations in the groundwater while remediation activities are being completed. Institutional controls will be necessary to prevent groundwater use at sites with leaching until remediation activities are completed and the contaminant concentrations in the groundwater are below Industrial Drinking Water Values. Five-year reviews will be included in this alternative until monitoring indicates that the site is protective of human health and the environment. The bio-venting will only be applicable to sites which are shown to leach organic contaminants from soils into the groundwater.

**Effectiveness.** Institutional controls will be effective in the short term for protection of human health by preventing groundwater use. Bio-venting is a technology that has been proven to aid in aerobic bio-degradation of non-halogenated organic contaminants and is a widely

accepted technology for the destruction of non-halogenated organic contaminants such as BTEX compounds. The bio-venting technology will do little to aid the destruction of halogenated organic contaminants (chlorinated solvents). The toxicity and volume are reduced using bio-venting/bio-degradation for non-halogenated organic contaminants; however, the alternative has no effect on the mobility of the contaminants. As the toxicity and volume of the contamination are reduced, the contamination will cease leaching to the groundwater. Therefore, in the long-term this alternative is effective in protecting the human health and the environment.

**Implementability.** Bio-venting uses common material for well construction and equipment that is readily available. The MDEQ accepts bio-venting for remediation of non-halogenated organic contaminants. Conditions for bio-degradation at the Kellogg sites such as temperature, pH, and nutrients fall within an acceptable range. A pilot test of bio-venting has been performed at one of the Kellogg sites and was shown to be successful for BTEX compounds. It is anticipated that the MIANG can enact and enforce all required institutional controls.

**Costs.** The cost associated with bio-venting may include the installation of the injection wells and associated equipment, groundwater monitoring, and five-year site reviews. The cost of this alternative is low to moderate compared to the aboveground technologies.

This alternative is retained for consideration in Section 4.0.

**3.2.1.2.5 Alternative: In-Situ Soil Treatment - Soil Stabilization/ Solidification.** This alternative includes solidifying or stabilizing the organic contaminants in the soil to prevent leaching to the groundwater. Soil stabilization/ solidification is accomplished by mixing the soil with materials that either bind the contaminants or chemically alter the contaminants so that the contaminants are less likely to leach. Pilot or bench scale tests will be required to determine the additives that will effectively stabilize or solidify the soil contaminants detected at the Kellogg sites.

This alternative is applicable and appropriate only for sites which have soil contaminants that pose a threat of leaching to groundwater. Monitoring wells will need to be sampled to assess the performance of the solidification. Reviews of the sites will be required every five years.

**Effectiveness.** Soil stabilization/solidification is a proven technology for inorganic contaminants, but has also been successfully used in remedial activities for organic contaminants. In-situ soil stabilization/solidification binds the contaminants, effectively reducing the mobility of the contaminants and protecting groundwater, therefore meeting the associated RAO. This alternative will not reduce the toxicity or volume of contaminated soil, nor will it reduce the concentration of the contaminants in the soil. This alternative will not provide any additional protection of human health. Since none of the Kellogg sites have organic contaminants in excess of the Industrial Direct Contact Value, the stabilized or solidified soil will meet the RAOs or ARARs for the protection of human health.

**Implementability.** The in-situ solidification can be performed with conventional equipment and materials. Special soil mixers can be used to achieve consistent solidification results as deep as 100 ft bgs. Bench scale testing will need to be performed to show that organic contaminants are stabilized in the soils.

**Costs.** The cost for this alternative may include contractor mobilization/ demobilization, fixation of soils, groundwater monitoring, and five-year site reviews. Costs are expected to be moderate to high for this alternative compared to other treatment alternatives due to the depths of the organic contaminants in the soil.

This alternative will be retained for further consideration at Kellogg sites where in-situ solidification is also used to stabilize inorganic contaminants.

**3.2.1.2.6 Alternative: In Situ Soil Treatment - Soil Vapor Extraction.** SVE uses several shallow vents (wells screened in the vadose zone) to pull air from the unsaturated zone to enhance VOC volatilization in the soil. By pulling ambient air from the surface and laterally

through soils containing VOCs, the VOCs can be collected. Contaminants that can be volatilized and be removed by SVE include BTEX compounds, most chlorinated solvents, and most aromatic hydrocarbons. The off-gas produced from SVE may need to be treated before being released to the atmosphere. This would depend on the concentration of the contaminants in the off-gas. A SVE pilot test would be required to provide necessary design information. Sampling of the soil during the treatment process may be necessary to track the contaminants as they are removed. Five-year reviews will be included in this alternative until monitoring indicates that the site is protective of human health and the environment. SVE will only be applicable to sites which are shown to leach volatile organic contaminants from the soil into the groundwater.

**Effectiveness.** SVE is a technology that has been proven to remove volatile organic contaminants from the soil and is widely accepted. The toxicity and volume are reduced using SVE for volatile organic compounds; however, the alternative has no effect on the mobility of the contaminants. As the toxicity and volume of the contaminants are reduced, the contaminants will cease leaching to the groundwater. Therefore, in the long-term this alternative is effective in protecting the environment and will meet ARARs and RAOs. In addition, this alternative will meet human health protection ARARs and RAOs at the Kellogg sites for organic contaminants in the soil.

**Implementability.** SVE uses common materials for well construction and equipment that is readily available. It is anticipated that the MIANG can enact and enforce all required institutional controls.

**Costs.** The cost associated with SVE may include the installation of wells and associated equipment, groundwater monitoring, and five-year site reviews. The cost of this alternative is moderate compared to the aboveground technologies.

This alternative is retained for consideration in Section 4.0.

**3.2.1.2.7 Alternative: Aboveground Soil Treatment - Thermal Desorption.** Thermal desorption is an aboveground treatment process. Contaminated soil will be excavated, treated using a thermal desorption unit, cooled, and used to backfill excavated areas.

This alternative is applicable and appropriate only to sites which have organic soil contaminants that pose a threat of leaching to groundwater. Groundwater will be monitored to assess contaminant levels in the groundwater while remediation activities are being completed. Once the treatment is complete, this site will not require additional monitoring or sampling.

**Effectiveness.** The toxicity, volume, and mobility of the organic contaminants in the soil are reduced or eliminated by this alternative. As these contaminants are removed, the contaminants will cease to pose a threat of leaching. Therefore, this alternative will meet ARARs and RAOs for protection of groundwater. This alternative meets human health protection ARARs and RAOs for the Kellogg sites.

**Implementability.** Thermal desorption uses common earth moving and moderately available processing equipment. Maximum soil contaminants are approximately 25 ft bgs which can be excavated by a full size excavator. Air permits are readily available for discharging off gas from the thermal desorber.

**Costs.** The cost for this alternative may include mobilization/demobilization, excavation, soil treatment, and groundwater monitoring. Cost associated with this alternative is high compared to other alternatives in this category.

This alternative is not retained for consideration is Section 4.0. Thermal desorption is more expensive than enhanced volatilization (discussed below), and enhanced volatilization will effectively treat all organic contaminants in the soils at the Kellogg sites.

**3.2.1.2.8 Alternative: Aboveground Soil Treatment - Enhanced Volatilization.** Enhanced volatilization is the process where a contaminant's natural tendency to vaporize into the

air is utilized. Soils containing volatile contaminants are excavated and processed in a pug mill or soil shredder. After treatment by enhanced volatilization in a pug mill or soil shredder, the soils are eventually used as backfill. Confirmatory sampling will be completed during the remediation to verify that contaminants are removed from the soil.

This alternative is applicable and appropriate only to sites which have soil contaminants that pose a threat of leaching to groundwater. Monitoring wells will need to be sampled to assess the performance of the enhanced volatilization.

**Effectiveness.** Enhanced volatilization is a recognized process for removing volatile organic contaminants from soils. The toxicity, volume, and mobility of the organic contaminants in the soil are reduced or eliminated, thus meeting all ARARs and RAOs for soils. Careful consideration will be given to the off-gas products so that they also meet applicable ARARs. Precautions will need to be taken during excavation to prevent worker exposure to non-cancer risks.

**Implementability.** Enhanced volatilization uses common earth moving and processing equipment. Maximum depth for excavation is approximately 25 ft, which can be excavated by a full size excavator. Air permits are readily available.

**Costs.** The cost for this alternative may include mobilization/demobilization, excavation, and soil treatment. Cost associated with this alternative is moderate compared to other soil treatment alternatives.

Enhanced volatilization is a viable alternative for the removal of volatile contaminants from soils. Therefore, enhanced volatilization is retained for further consideration.

### 3.2.2 Screening of Alternatives for Groundwater

For simplicity, this section presents screening of inorganic and organic groundwater alternatives separately. This provides sufficient information to determine the most appropriate alternatives to be retained for the detailed analysis in Section 4.0. In Section 4.0, the inorganic and organic

alternatives retained in this section are combined as needed for complete remediation of the groundwater at each site.

**3.2.2.1 Inorganic Groundwater Alternatives.** The alternatives evaluated for inorganic contaminants in the groundwater include:

- No Action
- Limited Action - Natural Attenuation, Monitoring, and Institutional Controls
- In-Situ Groundwater Treatment - Air Sparging
- Aboveground Groundwater Treatment- Ion Exchange

Table 3-3 contains a summary of screening completed in this section for the inorganic groundwater alternatives, including a listing of the alternatives retained for detailed analysis in Section 4.0. The following sections detail the screening process for each of the alternatives.

**3.2.2.1.1 Alternative: No Action**. The no action alternative serves as a baseline for comparison with the other alternatives. There are sites with contaminants over the Industrial Drinking Water Values, but the groundwater at Kellogg is not used as a source of drinking water. Therefore, there are no complete pathways for the contaminants in groundwater to reach humans. The no action alternative will not include monitoring, containment, or treatment of groundwater contaminants.

**Effectiveness.** Under the no action alternative, the toxicity, mobility and volume of groundwater contaminants will not be reduced. Since the groundwater contaminants will not be actively reduced in this alternative and there will be no additional monitoring to demonstrate possible natural attenuation, the ARARs and RAOs will not be met for Kellogg sites with groundwater contaminants in excess of Industrial Drinking Water Values.

**Implementability.** There will be no action to implement under this alternative.

**Costs.** There will be no cost associated with the no action alternative.

**TABLE 3-3**
**Summary of Screening for Inorganic Contaminants in Groundwater**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Effectiveness | Implementability | Relative Cost | Screening Result |
|---|---|---|---|---|
| No Action | MTV[a] not reduced.<br>Does not meet ARARs or RAOs for sites with groundwater contaminants exceeding Drinking Water Values. | No action to implement. | No cost | Retained[b] |
| Limited Action<br>Institutional Controls, Natural Attenuation, Monitoring | T and V will be reduced, M will not be reduced.<br>Can meet ARARs and RAOs in long-term.<br>Will likely provide overall protection of human health and the environment once natural attenuation occurs. | All actions are technically feasible and easily implemented. | Low cost | Retained[b] |
| In-situ Groundwater Treatment<br>Air Sparging | M is reduced, T and V are not reduced.<br>Meets ARARs and RAOs.<br>Provides overall protection of human health and the environment. | All actions are technically feasible and easily implemented. Materials are readily available.<br>Air sparge test required. | Low to moderate cost | Retained |
| Aboveground Groundwater Treatment<br>Ion Exchange | MTV reduced.<br>Meets ARARs and RAOs.<br>Provides overall protection of human health and the environment. | This alternative is technically feasible for treating organic contaminants in groundwater. The option requires common materials and equipment that is readily available. Groundwater modeling required. Pump test required. | Moderate cost | Retained |

Notes:
a) M=mobility, T=toxicity, V=volume
b) Under direction of ANG/CEVR, this option will be retained for the detailed analysis.

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The no action alternative is retained for further analysis. It serves as a baseline alternative with which the other alternatives can be compared.

**3.2.2.1.2 Alternative: Limited Action - Natural Attenuation, Monitoring, Institutional Controls.** Under the limited action alternative groundwater contaminants are not contained or treated, but are monitored for natural attenuation and migration. This alternative will include monitoring of groundwater to assess the site contamination. Depending on the specific site conditions, institutional controls may be necessary to prevent future use of groundwater until appropriate levels have been attained. This alternative will involve five year reviews of the site.

**Effectiveness.** Through institutional controls, the limited action can effectively prevent human exposure to the contaminated groundwater while natural attenuation is occurring. This alternative involves no active reduction of the toxicity, mobility, or volume of the groundwater contaminants. Natural attenuation of inorganic groundwater contaminants may occur by adsorption to organic content in the soil or by dilution of contaminants. Both adsorption and dilution will reduce the toxicity and volume of groundwater contaminants. Monitoring is necessary to confirm any natural attenuation. It is possible for inorganic contaminants in groundwater to meet ARARs and RAOs through natural attenuation.

**Implementability.** All activities required under this alternative are technically feasible. Long-term monitoring of groundwater and five-year review can be easily implemented. It is anticipated that the MIANG can enact and enforce institutional controls required to implement this alternative.

**Cost.** The cost for this alternative may include installation of additional wells, groundwater monitoring, five-year reviews, and any necessary institutional controls. The cost of this alternative is expected to be low compared to treatment options for inorganic contaminants in groundwater.

The limited action alternative with natural attenuation is retained for further analysis. This alternative provides a cost effective means for remediating site contaminants while providing protection of human health.

**3.2.2.1.3 In-Situ Groundwater Treatment - Air Sparging**. This alternative uses air sparging to effectively immobilize certain heavy metal contamination in groundwater. Some heavy metals oxidize forming a highly insoluble metal hydroxide. These metals include iron, zinc, cadmium, nickel, copper, lead, mercury and silver. Other metals such as arsenic and antimony coprecipitate when iron is oxidized. Analysis of the data presented in previous reports indicates that the groundwater does contain dissolved iron. The precipitate that forms is insoluble and will adhere to soil particles. An air sparging pilot test will be required to provide necessary design information. Depending on specific site conditions, institutional controls may be necessary to prevent future use of groundwater until appropriate levels are met. Five-year reviews will be required until treatment is complete.

**Effectiveness**. Air sparging is not usually performed for metal precipitation alone. It is usually a side benefit of air sparging for volatile organic removal. Heavy metal precipitation resulting from the addition of oxygen has been shown to be effective in many applications. While air sparging will not reduce the volume or toxicity of the metals it will effectively reduce the mobility of the metals.

**Implementability.** All activities required under this alternative are technically feasible. Groundwater monitoring and five-year reviews can be easily implemented. It is anticipated that MIANG can enact and enforce institutional controls required to implement this alternative.

**Costs.** The cost of this alternative may include installation of additional wells, groundwater monitoring, installation of the air sparge system, O&M of the air sparge system, five year reviews, and any necessary institutional controls. The cost of this alternative is expected to be low to moderate compared to other treatment options for inorganic contaminants in the groundwater.

Air sparging will be retained for further analysis. This alternative may provide an effective and relatively inexpensive means of meeting ARARs and RAOs at the Kellogg sites.

**3.2.2.1.4 Alternative: Aboveground Groundwater Treatment - Ion Exchange.** Ion exchange uses resins to remove ionic species from water. Ionic species include metals and some inorganic contaminants in the groundwater. This process does not remove inorganic contaminants which are non-ionic. Groundwater will be extracted from a network of wells and the collected groundwater will be sent to the ion exchange unit. After treatment, the groundwater will be reinjected into the aquifer.

This alternative will include monitoring groundwater to assess treatment. Depending on specific site conditions, institutional controls will be necessary to prevent future use of groundwater until appropriate levels are met. A bench scale test will be required to provide necessary design information. Five-year reviews will be required until appropriate levels are met.

**Effectiveness.** This alternative is effective in removing metals including arsenic and antimony and therefore reducing the volume, toxicity, or mobility of the metals in the groundwater. Ion exchange is capable of achieving levels of the metal contaminants necessary to obtain effluent discharge permits. Therefore, the process is capable of meeting all of the requirements of the ARARs and RAOs applying to inorganic contaminants in groundwater.

**Implementability.** Ion exchange has been used extensively by industry and in remediation projects. The resins and equipment are readily available commercially.

**Costs.** Cost for this alternative may include site preparation, groundwater modeling, groundwater injection permits, capital and operating cost for the ion exchange system, influent/effluent monitoring, continued groundwater monitoring and five-year reviews. Ion exchange is expected to be moderately expensive compared to other metals removal alternatives.

Even though the ion exchange alternative is moderately expensive, it is the most reliable alternative for treating inorganic contaminants to groundwater and is retained for further consideration.

**3.2.2.2 Organic Groundwater Alternatives.** The alternatives evaluated for organic contaminants in groundwater include:

- No Action
- Limited Action - Natural Attenuation, Monitoring, and Institutional Controls
- In-Situ Groundwater Treatment - Air Sparging
- Aboveground Groundwater Treatment - Adsorption
- Aboveground Groundwater Treatment - Air Stripping
- Aboveground Groundwater Treatment - Advanced Oxidation

Table 3-4 contains a summary of screening completed in this section for the organic groundwater alternatives, including a listing of the alternatives retained for detailed analysis in Section 4.0. The following sections detail the screening process for each of the alternatives.

**3.2.2.2.1 Alternative: No Action.** The no action alternative serves as a baseline for comparison with the other alternatives. There are sites with contaminants over the Industrial Drinking Water Values, but the groundwater at Kellogg is not used as a source of drinking water. Therefore, there are no complete pathways for the contaminants in groundwater to reach humans. The no action alternative will not include monitoring, containment, or treatment of groundwater contaminants.

**Effectiveness.** Under the no action alternative, the toxicity, mobility, and volume of groundwater contaminants will not be reduced. Since the groundwater contaminants will not be actively reduced in this alternative and there will be no additional monitoring to demonstrate possible natural attenuation, the ARARs and RAOs will not be met for Kellogg sites with groundwater contaminants in excess of Industrial Drinking Water Values.

**TABLE 3-4**
**Summary of Screening for Organic Contaminants in Groundwater**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Effectiveness | Implementability | Relative Cost | Screening Result |
|---|---|---|---|---|
| No Action | MTV[a] not reduced.<br>Does not meet ARARs or RAOs for sites with groundwater contaminants exceeding Drinking Water Values. | No action to implement. | No cost | Retained[b] |
| Limited Action<br>Institutional Controls, Natural Attenuation, and Monitoring | T and V will be reduced, M is not reduced.<br>Can meet ARARs and RAOs in long-term.<br>Will likely provide overall protection of human health and the environment once natural attenuation occurs. | All actions are technically feasible and easily implemented. | Low cost | Retained |
| In-situ<br>Air Sparging | M, T, and V are reduced.<br>Meets ARARs and RAOs. | This technology is technically feasible for treating VOCs.<br>The alternative requires common materials. Equipment is readily available.<br>Air sparge test required. | Low to moderate cost | Retained |
| Aboveground Groundwater Treatment<br>Adsorption | MTV reduced.<br>Meets ARARs and RAOs.<br>Provides overall protection of human health and the environment.<br>Possible liabilities associated with spent GAC units. | This alternative is technically feasible for treating organic contaminants in groundwater.<br>The alternative requires common materials and readily available equipment.<br>Groundwater modeling required.<br>Pump test required. | Moderate cost | Not retained |

**TABLE 3-4 (continued)**
**Summary of Screening for Organic Contaminants in Groundwater**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Effectiveness | Implementability | Relative Cost | Screening Result |
|---|---|---|---|---|
| Aboveground Groundwater Treatment<br>Air Stripping | MTV reduced.<br>Meets ARARs and RAOs.<br>Provides overall protection of human health and the environment. | This is a well developed technology which will be effective on the organic contaminants at this sites.<br>The alternative requires common materials and readily available equipment.<br>Groundwater modeling required. Pump test required. | Low to moderate cost | Retained |
| Aboveground Groundwater Treatment<br>Advanced Oxidation | MTV reduced.<br>Meets ARARs and RAOs.<br>Provides overall protection of human health and the environment. | This is a well developed technology which will be effective on the organic contaminants at these sites.<br>The alternative requires common materials. Equipment is readily available.<br>Groundwater modeling required. Pump test is required. | High cost | Not retained |

Notes:
a) M=mobility, T=toxicity, V=volume
b) Under direction of ANG/CEVR, this option will be retained for the detailed analysis.

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**Implementability.** There will be no action to implement under this alternative.

**Costs.** There will be no cost associated with the no action alternative.

The no action alternative is retained for further analysis for comparison with other alternatives. Although there are sites at Kellogg with detections over the Industrial Drinking Water Values, the RI Report data indicate that the groundwater contaminants have not migrated beyond the base boundaries and there are no human health risks associated with the contaminants. Therefore, the Kellogg sites are candidates for the no action alternative.

**3.2.2.2.2 Alternative: Limited Action - Natural Attenuation, Monitoring, and Institutional Controls.** Under the limited action alternative groundwater contaminants are not contained or treated, but monitored for natural attenuation and migration. This alternative will include monitoring of groundwater to assess the natural attenuation process. Depending on the specific site conditions, institutional controls will be necessary to prevent future use of groundwater until appropriate levels have been attained for contaminants. This alternative will involve five-year reviews of the site.

**Effectiveness.** Through institutional controls, the limited action can effectively prevent human exposure to the contaminated groundwater while natural attenuation is occurring. This alternative involves no active reduction of the toxicity, mobility, or volume of the groundwater contaminants. The contaminants in the groundwater will naturally attenuate to levels meeting ARARs and RAOs. As the contaminants naturally attenuate, there will be a reduction in the toxicity and volume of the contaminants.

**Implementability.** All activities required under this alternative are technically feasible. Long-term monitoring of groundwater and five-year reviews will be easily implemented. It is anticipated that the MIANG can enact and enforce the institutional controls required to implement this alternative.

**Costs.** The cost for this alternative may include installation of additional wells, sampling, five-year reviews, and any necessary institutional controls. The costs for this alternative are expected to be low compared with treatment alternatives for organic contaminants in groundwater. This alternative provides a cost effective means for remediating site contaminants while providing protection of human health. The limited action alternative with natural attenuation is retained for further analysis.

**3.2.2.2.3 Alternative: In-Situ Groundwater Treatment - Air Sparging.** The air sparging alternative uses a network of wells to inject air into groundwater. The injected air volatilizes the VOCs which then migrate to the surface. Air sparging also aids bio-degradation of organic contaminants that are not volatilized by the air sparge. This is accomplished by increasing the dissolved oxygen content of the water.

This alternative will include monitoring of groundwater to assess treatment. Depending on specific site conditions, institutional controls may be necessary to prevent the use of groundwater until appropriate levels are met. An air sparging pilot test will be required to provide necessary design information. Five-year reviews will be required until treatment is complete.

**Effectiveness.** Air sparging is a technology that has been proven to actively volatilize VOCs in groundwater. The toxicity, mobility, or volume of VOCs in the groundwater are reduced using air sparging. With time, air sparging meets ARARs and RAOs for organic contaminants in groundwater.

**Implementability.** Air sparging uses common materials for well construction and equipment that is readily available.

**Costs.** The cost associated with air sparging may include installation of the sparge wells and associated equipment, groundwater monitoring, and five-year site reviews. The cost of this alternative is expected to be moderate compared to other alternatives.

Air sparging is retained for consideration in Section 4.0.

**3.2.2.2.4 Alternative: Aboveground Treatment - Adsorption.** This alternative includes the extraction of groundwater through a network of wells or drains. Once extracted, groundwater will be treated on-site using the liquid-phase adsorption process described in Section 2.5. For organic contaminants in groundwater, granular activated carbon (GAC) generally performs best. The organic contaminants in the extracted groundwater will be adsorbed to the GAC until all of the adsorption sites on the carbon are occupied. Spent GAC can be regenerated. After treatment, the groundwater will be reinjected into the aquifer.

This alternative will include monitoring of groundwater to assess treatment. Depending on specific site conditions, institutional controls will be necessary to prevent future use of groundwater until appropriate levels are met. A pumping test will be required to provide necessary design information. Five-year reviews will be required until treatment is complete.

**Effectiveness.** Groundwater extraction wells are an effective and technically viable means of pumping groundwater to remove contaminant mass and control groundwater flow. GAC adsorption has been demonstrated effective in removing VOCs from groundwater. However, spent GAC units must be either disposed in a landfill creating a potential liability or regenerated. The combined elements of this alternative provide protection to human health and the environment by reducing the mobility, toxicity, and volume of contaminants in the groundwater. This alternative meets ARARs and RAOs.

**Implementability.** Extraction wells are commonly used for extraction of groundwater. Few major difficulties are expected to be encountered during construction and operation of the groundwater extraction and treatment system. Monitoring of the extraction and treatment system will be necessary to assess its reliability and performance. No difficulties are anticipated with long-term maintenance or replacement of site equipment or materials.

**Costs.** The cost for this alternative may include site preparation, groundwater modeling, groundwater injection permits, capital and operating costs for the network of wells, liquid-phase GAC adsorption treatment system, replacement GAC units, influent/effluent monitoring, continued groundwater monitoring, and five-year reviews. The cost for this alternative is expected to be moderate compared with other alternatives for treating organic contaminants in groundwater.

This alternative is not retained for further analysis in Section 4.0. Air stripping is an equally effective treatment technology which does not create a waste stream requiring disposal or treatment.

**3.2.2.2.5 Alternative: Aboveground Treatment - Air Stripping.** This alternative involves the extraction of groundwater through a series of wells followed by treatment of the extracted groundwater with an air stripping system. The air stripping system consists of a horizontal tray or packed column. VOCs are transferred from the water phase to the air phase in this process. After treatment, the groundwater will be reinjected into the aquifer.

This alternative will include monitoring of groundwater to assess treatment. Depending on specific site conditions, institutional controls will be necessary to prevent the use of groundwater until appropriate levels are met. A pumping test will be required to provide necessary design information. Five-year reviews will be required until treatment is complete.

**Effectiveness.** The groundwater extraction wells are an effective and technically viable means of extracting groundwater. Air stripping has been proven effective in removing VOCs from extracted groundwater. Air stripping is effective in reducing volume, toxicity, and mobility of the impacted media. ARARs and RAOs will be met under this alternative.

**Implementability.** Extraction well systems are commonly used for removal of contaminated groundwater. Few difficulties are expected to be encountered during construction and operation of the groundwater extraction and treatment system. Air stripping is a well

developed technology and has been successfully used to treat VOCs in groundwater. Monitoring of the extraction and treatment system will be necessary to assess its reliability and performance. No difficulties are anticipated with long-term maintenance or replacement of site equipment or materials.

**Costs.** The cost for this alternative may include site preparation, groundwater modeling, groundwater injection permits, capital and operating costs for construction of a network of extraction wells, air stripping treatment, influent/effluent monitoring, continued groundwater monitoring, and five-year reviews. The cost for this alternative is expected to be low to moderate relative to other treatment options for organic contaminants in groundwater.

Air Stripping is retained as a relatively inexpensive method of removing volatile organic contaminants from the groundwater.

**3.2.2.2.6 Alternative: Aboveground Groundwater Treatment - Advanced Oxidation.** This alternative uses extraction wells to remove contaminated groundwater from the aquifer. Extracted groundwater will be treated by advanced oxidation, which is particularly effective in destroying chlorinated organics and BTEX compounds. Treated groundwater will be reinjected into the aquifer.

This alternative will include monitoring of groundwater to assess treatment. Depending on specific site conditions, institutional controls may be necessary to prevent the use of groundwater until appropriate levels are met. A pumping test will be required to provide necessary design information. Five-year reviews will be required until treatment is complete.

**Effectiveness.** The groundwater extraction wells are an effective and technically viable means of extracting groundwater. Advanced oxidation has been proven effective in removing chlorinated organic and BTEX compounds from extracted groundwater. Advanced oxidation is effective in reducing volume, toxicity, and mobility of the contaminated media. ARARs and RAOs will be met under this alternative.

**Implementability.** Extraction well systems are commonly used for removal of contaminated groundwater. Few difficulties are expected to be encountered during construction and operation of the groundwater extraction and treatment system. Advanced oxidation is a well developed technology and has been proven to effectively treat VOCs in groundwater. Monitoring of the extraction and treatment system will be necessary to assess its reliability and performance, and to meet discharge permits. No difficulties are anticipated with long-term maintenance or replacement of site equipment or materials.

**Costs.** The cost for this alternative may include site preparation, groundwater modeling, groundwater injection permits, capital and operating costs for construction of a network of extraction wells, advanced oxidation treatment, influent/effluent monitoring, continued groundwater monitoring, and five-year reviews. The costs for this alternative are high relative to other treatment options for organic contaminants in groundwater.

Due to the high cost to benefit ratio at these sites, advanced oxidation is not cost effective. This alternative is not retained for further analysis in Section 4.0.

# 4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section combines media specific alternatives retained in Section 3.0 into site specific alternatives for each of the sites at Kellogg. The site specific alternatives are then subjected to a detailed analysis using the USEPA's nine criteria for evaluating remedial alternatives.

## 4.1 INTRODUCTION

The detailed analysis completed in this section is intended to provide decision-makers with sufficient information to select the appropriate remedial actions for each site.

The following is a list of the alternatives developed for each of the sites at Kellogg.

**Site 1 & AOC B**

| Alternative | Action |
|---|---|
| 1/B-1 | No Action |
| 1/B-2 | Limited Action for Groundwater and Soil (Natural Attenuation, Monitoring, and Restrictions) |
| 1/B-3 | Soil Cap for Soil and Natural Attenuation for Groundwater |
| 1/B-4 | Soil Cap for Soil and In-situ Groundwater Treatment (Air Sparging) |
| 1/B-5 | Soil Cap for Soil and Aboveground Groundwater Treatment (Air Stripping and Ion Exchange) |

**Site 3**

| Alternative | Action |
|---|---|
| 3-1 | No Action |
| 3-2 | Limited Action for Groundwater and Soil (Natural Attenuation, Monitoring, and Restrictions) |
| 3-3 | Clay Cap and In-situ Soil Treatment (Soil Vapor Extraction) for Soil and In-situ Groundwater Treatment (Air Sparging) |

| | |
|---|---|
| 3-4 | Enhanced Volatilization and Soil Cap for Soil and Aboveground Groundwater Treatment (Air Stripping) |

**AOC A**

| <u>**Alternative**</u> | <u>**Action**</u> |
|---|---|
| A-1 | No Action |
| A-2 | Limited Action for Soils (Natural Attenuation, Monitoring, and Restrictions) |
| A-3 | In-situ Stabilization/Solidification for Soil |
| A-4 | Clay Cap for Soil |

## 4.2 ASSESSMENT CRITERIA

Each appropriate alternative must meet the following criteria: Long-term Effectiveness, Reduction of Toxicity, Mobility, and Volume, Short-term Effectiveness, Implementability, and Cost. Two additional criteria will be evaluated following comment on the RI/FS Reports. They are: State or Support Agency Acceptance, and Community Acceptance. The nine criteria are explained in detail in the following paragraphs.

### 4.2.1 Short-Term Effectiveness

An evaluation of the effectiveness of alternatives in protecting human health and the environment during the construction and implementation of a remedy until the response objectives are met is included in the analysis. The time the alternative takes to meet the RAOs is also considered under this criterion.

### 4.2.2 Long-Term Effectiveness and Permanence

Long-term effectiveness of the alternative is evaluated with respect to the permanence of the alternative, whether the RAOs are met, the magnitude of residual risk, and the adequacy and reliability of controls used to manage remaining waste over the long term.

#### 4.2.3 Overall Protection of Human Health and Environment

The analysis includes an evaluation of how the alternative achieves and maintains overall protection of human health and the environment, including if the alternative reduces the risk from potential exposure pathways through treatment, engineering, and/or institutional controls.

#### 4.2.4 Implementability

Each alternative is evaluated for the technical and administrative implementability of the alternative and the availability of the goods and services needed to implement it.

#### 4.2.5 Cost

An alternative is evaluated in terms of its estimated 30-year present worth costs, which includes both capital costs, indirect costs, O&M costs, and review costs. A discount rate of 7 percent will be used in the estimates. An accuracy range of +50 percent to -30 percent is attempted for all the cost estimates.

#### 4.2.6 Reduction of Mobility, Toxicity, or Volume

Remedial alternatives are evaluated against the anticipated performance of the proposed treatment technologies.

#### 4.2.7 Compliance with ARARs

Under this criterion, the alternative is evaluated for its compliance with federal and state ARARs.

#### 4.2.8 State Acceptance

This criterion reflects the state's preferences or concerns for each alternative. State acceptance will be determined after review of this FS by the MDEQ.

#### 4.2.9 Community Acceptance

This criterion reflects the community's preferences or concerns for each alternative. Community involvement has yet to be solicited in the evaluation of alternatives. Community acceptance

criteria will not be included with each alternative until the community has been solicited to review the FS.

## 4.3 DETAILED ANALYSIS FOR SITE 1 AND AREA OF CONCERN B

Remedial action alternatives for Site 1 and AOC B soil and groundwater are presented below. Table 4-1 summarizes the results of the analysis of Site 1 and AOC B alternatives.

### 4.3.1 Alternative 1/B-1: No Action

The no action alternative serves as a baseline for comparison with other remedial alternatives. Under this alternative, no remedial actions will be performed at Site 1 and AOC B to contain or reduce the contamination in the soil and groundwater. An assessment of Alternative 1/B-1 follows:

**4.3.1.1 Short-Term Effectiveness.** This alternative will be ineffective in preventing human health and the environment from exposure to soil and groundwater contamination at Site 1 and AOC B.

**4.3.1.2 Long-Term Effectiveness.** This alternative will be ineffective over the long-term. The inorganic contamination will remain in surface soils. Organic contaminants in the groundwater may attenuate, however, there will be no data to verify the attenuation. The no action alternative will not meet ARARs or RAOs for Site 1 and AOC B.

**4.3.1.3 Implementability.** No action is required for implementation of this alternative. No services will be required to implement this alternative.

**4.3.1.4 Cost.** There is no cost associated with this alternative.

**4.3.1.5 Reduction of Toxicity, Mobility, or Volume.** The no action alternative will not result in active reduction of toxicity, mobility, or volume of contamination. There may be natural

**TABLE 4-1**
**Comparative Analysis of Remedial Alternatives for Site 1 and Area of Concern B**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Estimated Cost[a] | Overall Protection of Human Health and the Environment | Implementability | Reduction of Toxicity, Mobility, and Volume | Compliance with ARARs and RAOs |
|---|---|---|---|---|---|
| <u>1/B-1</u><br>No Action | $0 | No action will not be protective of human health or the environment. | No action to implement. | No active reduction in MTV[b] in soil or groundwater. | Will not meet ARARs or RAOs for groundwater or soil. |
| <u>1/B-2</u><br>Limited Action (Natural Attenuation, Monitoring, and Restrictions) | $74,300 - $159,300 | Offers higher level of protection for human health than 1/B-1. Potential for human contact with contaminants during maintenance (mowing) of fenced area.<br>Will not provide protection for environmental receptors (birds and small animals) from exposure to soil contaminants. | Activities planned under this alternative technically feasible.<br>Long-term institutional management, monitoring, and 5-year reviews required. | No active reduction in MTV.<br>Groundwater and organic soil contaminants will naturally attenuate; therefore reducing the TV.<br>There will be no reduction in the MTV of the inorganic soil contaminants. | As groundwater contaminants naturally attenuate, the groundwater will meet ARARs and RAOs.<br>Soil will not meet ARARs or RAOs due to the lead detection in excess of the Industrial Direct Contact Value. |
| <u>1/B-3</u><br>Soil Cap for Soil and Natural Attenuation for Groundwater | $91,800 - $196,600 | Will provide overall protection of human health and the environment.<br>Institutional controls will protect human health during the remediation activities. | Activities planned under this alternative are technically feasible.<br>Institutional management, monitoring, and 5-year reviews required. | No active reduction in MTV for groundwater contaminants. As groundwater contaminants naturally attenuate, there will be a reduction in TV.<br>Soil cap will not reduce MTV, but will prevent direct contact with the lead. | As the groundwater contaminants naturally attenuate, the groundwater will meet ARARs and RAOs.<br>With the cap in place, the soils will meet ARARs and RAOs. |

**TABLE 4-1 (Continued)**
**Comparative Analysis of Remedial Alternatives for Site 1 and Area of Concern B**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Estimated Cost[(a)] | Overall Protection of Human Health and the Environment | Implementability | Reduction of Toxicity, Mobility, and Volume | Compliance with ARARs and RAOs |
|---|---|---|---|---|---|
| **1/B-4**<br>Soil Cap for Soil and In-situ (Air Sparging) Treatment for Groundwater | $172,300 - $369,200 | Will provide overall protection of human health and the environment.<br><br>Institution controls will protect human health during the remediation activities. | Activities planned under this alternative are readily implemented.<br><br>Institutional management, monitoring, and a 5-year review required.<br><br>Air sparge pilot test required. | Groundwater treatment will reduce the MTV of the groundwater organic contaminants. The M of the inorganic contaminants will be reduced by the groundwater treatment.<br><br>Soil cap will not reduce MTV, but will prevent direct contact with the lead. | After treatment, the groundwater will meet ARARs and RAOs.<br><br>With the cap in place, the soils will meet ARARs and RAOs. |
| **1/B-5**<br>Soil Cap for Soil and Aboveground (Air Stripping and Ion Exchange) Treatment for Groundwater | $563,400 - $1,207,200 | Will provide overall protection of human health and the environment.<br><br>Institution controls will protect human health during the remediation activities. | Activities planned under this alternative are readily implemented.<br><br>Institutional management, monitoring, and a 5-year review required.<br><br>Pump test and bench scale test required. | Groundwater treatment will reduce the MTV of the groundwater contaminants.<br><br>Soil cap will not reduce MTV, but will prevent direct contact with the lead. | After treatment, the groundwater will meet ARARs and RAOs.<br><br>With the cap in place, the soils will meet ARARs and RAOs. |

(a) Present worth cost is calculated based on a 7 percent discount rate over the duration of the alternative.
(b) M=mobility, T=toxicity, V=volume

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attenuation of groundwater contamination, however, the no action alternative will not provide any means of monitoring the attenuation of contamination.

**4.3.1.6 Overall Protection of Human Health and the Environment.** The no action alternative will not be protective of human health or the environment. There will be no measures taken to prevent human contact with contaminated soil.

**4.3.1.7 Compliance with ARARs.** The no action alternative will not meet ARARs for groundwater or soil.

### 4.3.2 Alternative 1/B-2: Limited Action (Natural Attenuation, Monitoring, and Restrictions)

Under the limited action alternative, the soil and groundwater contaminants will not be contained or treated, but allowed to naturally attenuate. Institutional controls will be used to prevent human exposure to the inorganic contaminants in excess of the Industrial Direct Contact Value, and to prevent use of groundwater until it is determined to be protective of human health. Institutional controls will prevent the use of the groundwater and contaminated soil in the future. This alternative includes a fence around the former location of tank 1 (the location of the lead detection in excess of the Industrial Direct Contact Value). Monitoring of groundwater will allow for an assessment of the natural attenuation to determine when the sites no longer pose a threat to human health. It is anticipated that the limited action will require long-term use of institutional controls due to the lead in the surface soil.

**4.3.2.1 Short-Term Effectiveness.** Institutional controls will be effective in the short-term in preventing human exposure to soil or groundwater contamination at Site 1 and AOC B. There would be no threat to workers during the installation of the fence. The groundwater is not currently used at Kellogg as a source of drinking water, nor is its use planned in the future. With institutional controls in place, groundwater use should not be an issue.

The groundwater contamination at Site 1 and AOC B will not pose a problem off-site. Phenanthrene is considered highly bio-degradable and will not migrate off-site before reaching levels below Residential Drinking Water Values. Arsenic in groundwater is not considered mobile when the groundwater contains dissolved oxygen and iron. The fairly shallow aquifer at Kellogg has levels of dissolved oxygen and iron that will precipitate arsenic.

There is no active source for the phenanthrene in the groundwater. With no additional phenanthrene contribution, natural degradation will reduce the concentrations of phenanthrene to below the Residential Drinking Water Value.

There is no active source for PCE in the groundwater. With no additional PCE contribution, natural degradation, diffusion, and dispersion will reduce the concentrations of PCE to below the Residential Drinking Water Value.

Based on information presented in the RI Report, leaching of contaminants from soil does not appear to be a concern at Site 1 and AOC B. Continued sampling of groundwater will provide information to monitor the natural attenuation of contamination at the sites. It is anticipated that natural attenuation of the contaminants in the groundwater will occur within ten to fifteen years. The inorganic contaminants in the soil are not expected to attenuate.

**4.3.2.2 Long-Term Effectiveness.** Human risk from direct contact with surface soils will be reduced for the lifetime of the fence, approximately 30 to 50 years. Experience has shown that inorganic contaminants in soil do not naturally attenuate. Therefore, it is not expected that the lead will attenuate to below the ARARs. This alternative will not meet soil ARARs and RAOs. It is expected that groundwater contaminants will naturally attenuate, therefore meeting groundwater ARARs and RAOs. The groundwater contaminants were not detected in the soil, indicating that the soil is not the current source of the groundwater contamination. Contaminants are the result of past activities at the sites that have been discontinued. The groundwater contaminants are not anticipated to increase, but only decrease with natural attenuation; therefore

meeting RAOs. Five-year reviews will be necessary to determine when the groundwater is protective of human health and the monitoring of groundwater can be discontinued.

**4.3.2.3 Implementability.** Technical and administrative feasibility of Alternative 1/B-2 and the availability of the goods and services needed to implement the alternative are as follows:

**4.3.2.3.1 Technical Feasibility.** Activities planned under this alternative are technically feasible. The groundwater monitoring, and five-year reviews required for this alternative can be implemented. Restricted access to the fenced area can be monitored in the controlled environment at Kellogg.

**4.3.2.3.2 Administrative Feasibility.** Long-term institutional management will be associated with this alternative due to the lead detection remaining on-site in the soil. It is expected that the MIANG will be able to implement and enforce the required institutional controls for these sites.

**4.3.2.3.3 Availability of Services and Materials.** Contractor services are readily available to complete the groundwater monitoring, five-year reviews, and installation of the fencing.

**4.3.2.4 Cost.** The cost associated with this alternative is presented in Table 4-2. Assuming a 7 percent discount rate, the 15-year, present-worth cost for this alternative is $106,200 (plus 50% to minus 30%).

**4.3.2.5 Reduction of Toxicity, Mobility, or Volume.** The limited action alternative will not actively reduce the toxicity, mobility, and volume of the contaminants. As natural attenuation occurs, there will be a reduction in the toxicity, volume, and mobility of groundwater as discussed in the Short Term Effectiveness Section 4.3.2.1. This alternative will not result in a reduction of the mobility, toxicity, or volume of inorganic contaminants in the soil.

**TABLE 4-2**
**Cost Estimate for Alternative 1/B-2: Limited Action**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS (DDC)** | | | | |
| Institutional Controls (Note 1) | 1 | lump sum | | $15,000 |
| Well Installation (Note 2) | 1 | lump sum | | $1,600 |
| Soil Investigation (Note 3) | 1 | lump sum | | $3,000 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Contingency (Note 5) | 1 | lump sum | | $5,000 |
| | *TOTAL CAPITAL COSTS* | | | $24,600 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 6) | 1 | yearly | | $8,000 |
| | *TOTAL ANNUAL COSTS* | | | $8,000 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEWS | | | | |
| Planning | 1 | lump sum | | $500 |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $3,500 |
| Report Preparation | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 15 | | | |
| | *TOTAL PRESENT WORTH* | | | $106,174 |

Notes refer to assumptions used in the preparation of the cost estimate. All notes are listed in Appendix A-1.

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**4.3.2.6 Overall Protection of Human Health and the Environment.** This alternative will offer a higher level of human health protection than Alternative 1/B-1 since it will reduce the potential for direct human contact or ingestion of soil contaminants. There is potential for workers to contact the soil contaminants during maintenance activities such as mowing. The use of institutional controls for groundwater will eliminate the future use of groundwater. This alternative will not protect environmental receptors (i.e., birds and small animals) from potential exposure to surface soil contaminants.

**4.3.2.7 Compliance with ARARs.** As the contaminants in the groundwater naturally attenuate, the groundwater will meet ARARs. The lead will not attenuate to levels meeting the ARARs. Therefore, Alternative 1/B-2 does not meet ARARs for soils.

### 4.3.3 Alternative 1/B-3: Soil Cap for Soil and Natural Attenuation for Groundwater

Alternative 1/B-3 will include the placement of a soil cap over surface soils to prevent human contact with the lead detection in excess of the Industrial Direct Contact Value. The cap will consist of 18 inches of soil which will be seeded with grass. There will be no treatment or containment for groundwater contaminants; instead, the groundwater contaminants will be monitored for natural attenuation.

This alternative will include institutional controls to prevent human exposure to the lead at concentrations in excess of the Industrial Direct Contact Value and to prevent use of groundwater until the actions are completed for this alternative. Continued monitoring of the groundwater will be conducted to assess the natural attenuation of the contaminants, and to determine when contaminants in the groundwater no longer pose a threat to human health. Based on the information presented in the RI Report, leaching of soil contaminants does not appear to be a concern at Site 1 and AOC B. Five-year reviews will be conducted as part of this alternative until monitoring shows that groundwater contaminants have attenuated to below ARARs.

**4.3.3.1 Short-Term Effectiveness.** This alternative will immediately provide protection of human health and the environment. There would be no additional environmental contamination

created by this alternative. Installation of the soil cap may produce minor amounts of fugitive dust over a short time. This dust should pose no threat to the community, but may pose a minor threat to remedial action workers. Protection of workers will be achieved with proper protective clothing and masks, and by spraying with the soil with water to suppress dust. There are no current groundwater users and institutional controls will restrict future use. The Short-Term Effectiveness Section 4.3.2.1 describes the natural attenuation of contaminants in groundwater.

The soil cap installation can be completed within one year. The natural attenuation of the groundwater contaminants is expected to take between 10 and 15 years.

**4.3.3.2 Long-Term Effectiveness.** The cap will provide effective protection against contact with the soil contaminants above the Industrial Direct Contact Value for the long term. The contaminants detected in the groundwater are strong candidates for natural attenuation and it is expected that the groundwater contaminants will attenuate to levels below ARARs. The groundwater contaminants were not detected in the soil indicating that the soil is not likely the source of the groundwater contaminants. No sources were identified in previous reports for groundwater contaminants, therefore, with natural attenuation, the groundwater contaminants will decrease and no longer pose a threat to human health or the environment. Five-year reviews will be completed at these sites until the sites are determined not to pose a threat to human health or the environment.

**4.3.3.3 Implementability.** Technical and administrative feasibility of Alternative 1/B-3 and the availability of the goods and services needed to implement the alternative are as follows:

**4.3.3.3.1 Technical Feasibility.** All site activities planned under this alternative are technically feasible. The groundwater monitoring, soil cap, and five-year reviews required for this alternative can be implemented. Maintenance of the cap will include mowing and fertilizing of grass; these activities are already part of Kellogg's routine landscaping activities.

**4.3.3.3.2 Administrative Feasibility.** Institutional Controls will be associated with this alternative while groundwater contaminants are naturally attenuating. Institutional controls for the

soil cap will need to be enforced. It is expected that the MIANG will be able to implement and enforce the required institutional controls for these sites.

**4.3.3.3.3 Availability of Services and Materials.** Contractor services are readily available to complete the groundwater monitoring, to construct and maintain the cap, and to complete the five-year reviews.

**4.3.3.4 Cost.** The cost associated with this alternative is presented in Table 4-3. Assuming a 7 percent discount rate, the 30-year, present-worth cost for this alternative is $131,100 (plus 50% to minus 30%).

**4.3.3.5 Reduction of Toxicity, Mobility, or Volume.** This alternative will not result in active reduction of the toxicity, mobility, and volume of the groundwater contaminants. As the natural attenuation occurs, there will be a reduction in the toxicity, volume, and mobility of groundwater contaminants. The soil cap will not reduce the toxicity, mobility, or volume of the lead contamination in the soils. The soil cap will prevent direct human contact with the lead at concentrations in excess of the Industrial Direct Contact Value. Based on the information presented in the RI Report, this is the only concern that needs to be addressed for the soil.

**4.3.3.6 Overall Protection of Human Health and the Environment.** This alternative is expected to provide overall protection of human health and the environment. Institutional controls will provide protection of human health during remediation activities. Once the remedial actions have been completed for this alternative, the groundwater and soil at these sites will pose no risk to human health or the environment.

**4.3.3.7 Compliance with ARARs.** Once the contaminated soil is no longer at the surface, and institutional controls are in place to prevent future excavation, this alternative will meet ARARs for the soil contaminants. As the contaminants in the groundwater naturally attenuate, the groundwater will meet ARARs.

**TABLE 4-3**
**Cost Estimate for Alternative 1/B-3: Cap for Soils and Natural Attenuation for Groundwater**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS** | | | | |
| Institutional Controls (Note 1) | 1 | lump sum | | $15,000 |
| PRE-DESIGN ACTIVITIES | | | | |
| Work Plans/Sampling Plans (Note 12) | 1 | lump sum | | $4,000 |
| Well Installation (Note 2) | 1 | lump sum | | $2,000 |
| Soil Investigation (Note 3) | 1 | lump sum | | $4,000 |
| SOIL CAP (Note 7) | | | | |
| Mobilization/Demobilization (Note 14) | 1 | lump sum | $1,000 | $1,000 |
| Site Grading (Including Material Placement) | 52 | cu yd | $5 | $260 |
| Cap | 80 | sq yd | $8 | $640 |
| Reseed/Fertilize | 0.02 | acre | $2,650 | $43 |
| | *DIRECT CAPITAL COSTS (DDC)* | | | $26,943 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Engineering | | 6%of DCC | | $1,617 |
| Permitting | | 8% of DCC | | $2,155 |
| Construction Oversight/Technical Support | | 15% of DCC | | $4,041 |
| Contingency | | 20% of DCC | | $5,389 |
| | *INDIRECT CAPITAL COST* | | | $13,202 |
| | *TOTAL CAPITAL COSTS* | | | $40,145 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 5) (15 years) | 1 | yearly | | $8,000 |
| CAP MAINTENANCE | | | | |
| Maintenance Costs (Note 6) (30 year) | 1 | yearly | | $500 |
| | *TOTAL ANNUAL COSTS* | | | $8,500 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEW | | | | |
| Planning | | | | |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $500 |
| Report Preparation | 1 | lump sum | | $3,500 |
| | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 30 | | | |
| | *TOTAL PRESENT WORTH* | | | $131,080 |

Notes refer to assumptions used in the preparation of the cost estimate. All notes are listed in Appendix A-1.

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### 4.3.4 Alternative 1/B-4: Soil Cap for Soil and In-Situ Groundwater Treatment (Air Sparging)

Alternative 1/B-4 will include the placement of a soil cap to prevent human contact with the lead at concentrations in excess of the Industrial Direct Contact Value. The cap will consist of 18 inches of soil which will be seeded with grass. This alternative will also include treatment of the groundwater contaminants by air sparging. An air sparge pilot test will be conducted to provide necessary design information. Groundwater will be sampled throughout the remediation activities to monitor the levels of the groundwater contaminants.

The alternative will include institutional controls to prevent human exposure to the lead detection and to prevent the use of groundwater until the remedial actions are completed for this alternative. Based on the information presented in the RI Report, leaching of soil contaminants does not appear to be a concern at these sites. A five-year review will be completed as part of this alternative.

**4.3.4.1 Short-Term Effectiveness.** This alternative will provide immediate protection of human health and the environment. There are no current groundwater users, and institutional controls will prevent future use.

Air sparging will remove the volatile contaminants from the groundwater. Organic contaminants in the groundwater that are not volatile will be degraded by the enhanced bio-degradation that the added oxygen stimulates. The arsenic in the groundwater will become immobile due to oxygen enhanced iron coprecipitation. An SVE system may be required to capture the injected air with the volatile contaminants.

Installation of the soil cap may produce minor amounts of fugitive dust over a short time. This dust should pose no threat to the community, but may pose a minor threat to remedial action workers. Protection of workers will be achieved with proper protective clothing and masks, and by spraying with water to suppress dust.

Soil cap installation can be completed within one year. The low levels of contaminants in the groundwater will result in a short remediation time for groundwater. The air sparging system would complete removal of the contaminants to levels below the Industrial Drinking Water Values within two years.

**4.3.4.2 Long-Term Effectiveness.** The cap will provide effective protection against contact with soil contaminants above the Industrial Direct Contact Values in the long term. Air sparging will effectively treat and remove or immobilize the groundwater contaminants. The contaminants in the groundwater were not detected in the soil, indicating that the soil is not likely the source of the groundwater contaminants No sources were identified in previous reports for the groundwater contaminants, therefore, with air sparging, the groundwater contaminants will decrease and no longer pose a threat to human health or the environment. One five year review will be required to assess the remediation and condition of site groundwater.

**4.3.4.3 Implementability.** Technical and administrative feasibility of Alternative 1/B-4 and the availability of the goods and services needed to implement the alternative are as follows:

**4.3.4.3.1 Technical Feasibility.** Site activities planned under this alternative are technically feasible. The groundwater monitoring, soil cap, air sparging, and the five-year review required for this alternative are readily implementable.

**4.3.4.3.2 Administrative Feasibility.** Institutional controls will be associated with this alternative. Institutional controls for the soil cap will need to be enforced and landscaping care of the vegetation is necessary to prevent erosion. It is expected that the MIANG will be able to implement and enforce the required institutional controls for these sites.

**4.3.4.3.3 Availability of Services and Materials.** Contractor services are readily available to complete the groundwater monitoring, to construct the soil cap, to complete the installation and O&M of the air sparging system, and to complete the five-year review.

**4.3.4.4 Cost.** The cost associated with this alternative is presented in Table 4-4. Assuming a 7 percent discount rate, the 30-year, present-worth cost for this alternative is $246,200 (plus 50% to minus 30%).

**4.3.4.5 Reduction of Toxicity, Mobility, or Volume.** The cap will not result in a reduction of the toxicity, mobility, and volume of the soil contaminants. The air sparging will result in the reduction of the toxicity, mobility, and volume of the organic contaminants in the groundwater. Air sparging will also result in the reduction of the mobility of inorganic contaminants, but will not reduce toxicity or volume of inorganic contaminants.

**4.3.4.6 Overall Protection of Human Health and the Environment.** Public health and the environment will be protected by this alternative by eliminating the potential for contact with soil contaminants in excess of the Industrial Direct Contact Value and groundwater. Based on the information in the RI Report, the contaminants detected at Site 1 and AOC B do not pose a threat of leaching to the groundwater. Once remedial actions are complete for groundwater, the institutional controls related to the contaminated groundwater will be removed.

**4.3.4.7 Compliance with ARARs.** Once the contaminated soils are no longer at the surface, and institutional controls are in place to prevent future excavation, this alternative will meet ARARs for the soil contaminants. Air sparging will reduce groundwater contaminants to levels that meet all chemical specific ARARs.

### 4.3.5 Alternative 1/B-5: Soil Cap for Soil and Aboveground Groundwater Treatment (Adsorption and Ion Exchange)

Alternative 1/B-5 will include the placement of a soil cap to prevent human contact with the lead at concentrations in excess of the Industrial Direct Contact Value. The cap will consist of 18 inches of soil which will be seeded with grass. This alternative will also include aboveground treatment of the groundwater by adsorption (for organic contaminants) and ion exchange (for inorganic contaminants). A pumping test and bench scale test will be completed to provide

**TABLE 4-4**
**Cost Estimate for Alternative 1/B-4: Cap and Air Sparging for Soils and In-Situ Groundwater Treatment**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS (DDC)** | | | | |
| Institutional Controls (Note 1) | 1 | lump sum | | $10,000 |
| PRE-DESIGN ACTIVITIES | | | | |
| Work Plans/Sampling Plans (Note 12) | 1 | lump sum | | $4,000 |
| Air Sparge Pilot Test | 1 | lump sum | | $10,000 |
| Well Installation (Note 2) | 1 | lump sum | | $2,000 |
| Soil Investigation (Note 3) | 1 | lump sum | | $4,000 |
| SOIL CAP (Note 7) | | | | |
| Site Grading (Including Material Placement) | 52 | cu yd | $5 | $260 |
| Cap | 80 | sq yd | $8 | $640 |
| Reseed/Fertilize | 0.02 | acre | $2,650 | $43 |
| IN-SITU AIR SPARGING FOR GROUNDWATER (Equipment and Construction Cost) (Note 7) | | | | |
| Capital Equipment Costs | 1 | lump sum | $15,000 | $15,000 |
| Mechanical Installation | 1 | lump sum | $17,000 | $17,000 |
| Electrical Installation | 1 | lump sum | $1,750 | $1,750 |
| Building Installation | 1 | lump sum | $3,000 | $3,000 |
| Well Installation | 20 | wells | $1,600 | $32,000 |
| Trenching and Underground Piping | 400 | ft | $20 | $8,000 |
| Mobilize/Demobilize (5%)(Note 14) | | | | $5,385 |
| | *DIRECT CAPITAL COSTS (DDC)* | | | $113,078 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Engineering | | 6% of DDC | | $6,785 |
| Permitting | | 8% of DDC | | $9,046 |
| Construction Oversight/Tech. Support | | 15% of DDC | | $16,962 |
| Contingency | | 20% of DDC | | $22,616 |
| | *INDIRECT CAPITAL COSTS* | | | $55,408 |
| | *TOTAL CAPITAL COSTS* | | | $168,486 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 5) ( 5 years) | 1 | yearly | | $8,000 |
| CAP MAINTENANCE | | | | |
| Maintenance Costs (Note 6) (30 years) | 1 | yearly | | $500 |
| AIR SPARGING SYSTEM | | | | |
| Treatment Costs (Note 8) (2 years) | 1 | yearly | | $3,650 |
| Maintenance Costs (Note 9) (2 years) | 1 | yearly | | $11,175 |
| | *TOTAL ANNUAL COSTS* | | | $23,325 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEW | | | | |
| Planning | 1 | lump sum | | $500 |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $3,500 |
| Report Preparation | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 30 | | | |
| | *TOTAL PRESENT WORTH* | | | $246,162 |

necessary design information. Groundwater sampling will be completed to monitor the groundwater contaminants as the remediation is being completed.

This alternative will include institutional controls to prevent human exposure to lead detection and to prevent use of the groundwater until the remedial actions are completed for this alternative. Based on the information presented in the RI Report, leaching of soil contaminants does not appear to be a concern at these sites. Five-year reviews will be completed until remediation activities are complete.

**4.3.5.1 Short-Term Effectiveness.** This alternative will provide immediate protection of human health and the environment. There are no current groundwater users, and institutional controls will prevent future use.

Carbon adsorption will remove the organic contaminants from the groundwater. Arsenic in the groundwater will be removed using ion exchange. The re-injection wells and extraction wells will be placed to maximize capture of the contamination.

Installation of the soil cap may produce minor amounts of fugitive dust over a short time. This dust should pose no threat to the community, but may pose a minor threat to remedial action workers. Protection of workers will be achieved with proper protective clothing and masks, and by spraying the soil with water for dust suppression.

Soil cap installation can be completed within one year. Aboveground treatment is expected to take longer than the air stripping technology evaluated in Alternative 1/B-4. The aboveground treatment system would probably reduce contamination to levels below the Industrial Drinking Water Values in 5 to 10 years.

**4.3.5.2 Long-Term Effectiveness.** The cap will provide effective long-term protection against contact with soil contaminants above the Industrial Direct Contact Values. Carbon adsorption and ion exchange will effectively treat and remove the groundwater contaminants. The

contaminants in the groundwater were not detected in the soil, indicating that the soil is not likely the source of the groundwater contaminants. No sources were identified in previous reports for the groundwater contaminants, therefore, with aboveground groundwater treatment, the groundwater contaminants will decrease and no longer pose a threat to human health or the environment. Five-year reviews will be completed during remediation activities to assess the remediation of site groundwater.

**4.3.5.3 Implementability.** Technical and administrative feasibility of Alternative 1/B-5 and the availability of the goods and services needed to implement the alternative are as follows:

**4.3.5.3.1 Technical Feasibility.** Site activities planned under this alternative are technically feasible. The groundwater monitoring, the soil cap, the ion exchange system, the adsorption system, and five-year reviews required for this alternative can be implemented.

**4.3.5.3.2 Administrative Feasibility.** Institutional management will be associated with this alternative while groundwater contaminants are being treated. Institutional controls for the soil cap will need to be enforced and landscaping care of the vegetation is necessary to prevent erosion. It is expected that the MIANG will be able to easily implement and enforce the required institutional controls for these sites.

**4.3.5.3.3 Availability of Services and Materials.** Contractor services are readily available to complete the groundwater monitoring, to construct the soil cap, to complete the installation and O&M of the groundwater treatment system, and to complete the five-year reviews.

**4.3.5.4 Cost.** The cost associated with this alternative is presented in Table 4-5. Assuming a 7 percent discount rate, the 30-year, present-worth cost for this alternative is $804,800 (plus 50% to minus 30%).

**TABLE 4-5**
**Cost Estimate for Alternative 1/B-5: Cap of Soils and Aboveground Groundwater Treatment**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS (DDC)** | | | | |
| Institutional Controls (Note 1) | 1 | lump sum | | $10,000 |
| PRE-DESIGN ACTIVITIES | | | | |
| Work Plans/Sampling Plans (Note 13) | 1 | lump sum | | $7,000 |
| Bench Scale Test/Pump Test | 1 | lump sum | | $17,000 |
| Well Installation (Note 2) | 1 | lump sum | | $2,000 |
| Soil Investigation (Note 3) | 1 | lump sum | | $4,000 |
| SOIL CAP (Note 7) | | | | |
| Site Grading (Including Material Placement) | 52 | cu yd | $5 | $260 |
| Cap | 80 | sq yd | $8 | $640 |
| Reseed/Fertilize | 0.02 | acre | $2,650 | $43 |
| ABOVEGROUND GROUNDWATER TREATMENT (Equipment and Construction Cost) (Note 7) | | | | |
| Capital for Treatment System | 1 | lump sum | $118,500 | $118,500 |
| Mechanical Installation | 1 | lump sum | $17,900 | $17,900 |
| Electrical Installation | 1 | lump sum | $7,400 | $7,400 |
| Building Installation | 1 | lump sum | $15,000 | $15,000 |
| Extraction and Injection Well Installation | 3 | well | $4,000 | $12,000 |
| Injection Well Installation | 1 | well | $2,000 | $2,000 |
| Trenching and Underground Piping | 200 | ft | $36 | $7,200 |
| Mobilize/Demobilize (5%)(Note 14) | | | | $11,047 |
| | *DIRECT CAPITAL COSTS (DDC)* | | | $231,990 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Engineering | | 6% of DDC | | $13,919 |
| Permitting | | 8% of DDC | | $18,559 |
| Construction Oversight/Tech. Support | | 15% of DDC | | $34,799 |
| Contingency | | 20% of DDC | | $46,398 |
| | *INDIRECT CAPITAL COSTS* | | | $113,675 |
| | *TOTAL CAPITAL COSTS* | | | $345,665 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 5) (10 years) | 1 | yearly | | $8,000 |
| CAP MAINTENANCE | | | | |
| Maintenance Costs (Note 6) (30 years) | 1 | yearly | | $500 |
| GROUNDWATER TREATMENT | | | | |
| Treatment Costs (Note 8) (10 years) | 1 | yearly | | $12,400 |
| Influent/Effluent Monitoring (Note 11) (10 years) | 1 | yearly | | $22,700 |
| Maintenance Costs (Note 9) (10 years) | 1 | yearly | | $19,700 |
| | *TOTAL ANNUAL COSTS* | | | $62,800 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEW | | | | |
| Planning | 1 | lump sum | | $500 |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $3,500 |
| Report Preparation | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 30 | | | |
| *TOTAL PRESENT WORTH* | | | | $804,820 |

Notes refer to assumptions used in the preparation of the cost estimate. All notes are listed in Appendix A-1.

**4.3.5.5 Reduction of Toxicity, Mobility, or Volume.** The cap will not reduce the toxicity, mobility, or volume of the soil contaminants. The aboveground groundwater treatment system will result in the reduction of the toxicity, mobility, and volume of the groundwater contaminants.

**4.3.5.6 Overall Protection of Human Health and the Environment.** Human health and the environment will be protected by this alternative by eliminating the potential for contact with soil contaminants in excess of the Industrial Direct Contact Criteria and groundwater contamination. Based on the information in the RI Report, the contaminants detected at Site 1 and AOC B do not pose a threat of leaching to the groundwater. Once remedial actions are complete for groundwater, the institutional controls related to contaminated groundwater will be removed.

**4.3.5.7 Compliance with ARARs.** Once the contaminated soil is no longer at the surface, and institutional controls are in place to prevent future excavation, this alternative will meet ARARs for the soil contaminants. The aboveground groundwater treatment system will reduce groundwater contaminants to levels that meet all chemical specific ARARs.

**4.3.6 Comparison of Alternatives for Site 1 and Area of Concern B.**

The purpose of this analysis is to evaluate the relative advantages and disadvantages between different alternatives.

**4.3.6.1 Short-Term Effectiveness.** All alternatives except Alternatives 1/B-1 provide short-term effectiveness in the protection of human health and the environment. Alternatives 1/B-3, 1/B-4, and 1/B-5 present a slight threat to remedial workers due to disturbance of contaminated soils, but this can be minimized through standard health and safety precautions.

**4.3.6.2 Long-Term Effectiveness.** Alternatives 1/B-1 and 1/B-2 provide no assurance of long-term effectiveness. Alternatives 1/B-3, 1/B-4, and 1/B-5 provide long-term protection against direct contact with the lead contamination. Alternatives 1/B-4 and 1/B-5 provide permanent removal of the organic and inorganic contaminants in the groundwater. Alternatives 1/B-2 and 1/B-3 will provide long-term protection of the groundwater through reduction of the

contaminants by natural attenuation. Only Alternatives 1/B-3, 1/B-4, and 1/B-5 meet all soil and groundwater RAOs.

**4.3.6.3 Implementability.** The technical and administrative feasibility of the alternatives and the availability of the materials and services needed to implement the alternatives are compared below:

**4.3.6.3.1 Technical Feasibility.** All alternatives are technically feasible.

**4.3.6.3.2 Administrative Feasibility.** No problems are anticipated for any alternative regarding administrative feasibility.

**4.3.6.3.3 Availability of Services and Materials.** Materials for all alternatives are readily available.

**4.3.6.4 Cost.** Costs for each alternative are presented in Table 4-1.

**4.3.6.5 Reduction of Toxicity, Mobility, Volume.** Alternative 1/B-1 will not result in active reduction of the mobility, toxicity, or volume of the soil or groundwater contaminants. None of the alternatives will result in a reduction of the mobility, toxicity, or volume of the inorganic contaminants in the soils. With time, Alternatives 1/B-2 and 1/B-3 will result in the reduction of the toxicity or volume of the groundwater contaminants through natural attenuation. Alternatives 1/B-4 and 1/B-5 will actively reduce the toxicity, mobility, or volume of the groundwater contaminants.

**4.3.6.6 Overall Protection of Human Health and the Environment.** All of the alternatives except Alternative 1/B-1 provide immediate protection of human health. Alternative 1/B-1 and 1/B-2 make no provisions for the protection of environmental receptors from soil contaminants. Alternatives 1/B-3, 1/B/4, and 1/B-5 provide long-term protection of human health and the environment.

**4.3.6.7 Compliance with ARARs.** Only Alternatives 1/B-3, 1/B-4 and 1/B-5 will meet ARARs for soils. After active remediation is complete for groundwater, Alternatives 1/B-4 and 1/B-5 will meet ARARs. Alternatives 1/B-2 and 1/B-3 will meet ARARs for groundwater after natural attenuation has taken place.

## 4.4 DETAILED ANALYSIS FOR SITE 3

Remedial action alternatives for Site 3 soil and groundwater are presented below. Table 4-6 summarizes the result of the analysis of Site 3 alternatives.

### 4.4.1 Alternative 3-1: No Action

The no action alternative serves as a baseline for comparison with other remedial alternatives. Under this alternative, no remedial actions will be performed at Site 3 to contain or reduce the contaminants in the soil and groundwater. An assessment of Alternative 3-1 follows:

**4.4.1.1 Short-Term Effectiveness.** This alternative will be ineffective in the short-term in protecting human health and the environment from soil and groundwater contaminants at Site 3.

**4.4.1.2 Long-Term Effectiveness.** This alternative will be ineffective over the long-term. The inorganic contaminants will remain in the soils. Contaminants in the soil and groundwater may attenuate, however there will be no data to verify the attenuation. The no action alternative does not meet ARARs or RAOs for Site 3.

**4.4.1.3 Implementability.** No action is required for implementation of this alternative. No services will be required to implement this alternative.

**4.4.1.4 Cost.** There will be no cost associated with this alternative.

**TABLE 4-6**
**Comparative Analysis of Remedial Alternatives for Site 3**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Estimated Cost[a] | Overall Protection of Human Health and the Environment | Implementability | Reduction of Toxicity, Mobility, and Volume | Compliance with ARA and RAOs |
|---|---|---|---|---|---|
| 3-1<br>No Action | $0 | No action will not be protective of human health or the environment. | No action to implement. | No active reduction in MTV[b] in soil or groundwater. | Will not meet ARARs or RAOs for groundwater o soil. |
| 3-2<br>Limited Action (Natural Attenuation, Monitoring, and Restrictions) | $114,600 - $245,600 | Offers higher level of protection for human health than 3-1. Potential for human contact with contaminants during maintenance (mowing) of fenced area.<br>Will not provide protection for environmental receptors (birds and small animals) from exposure to soil contaminants. | Activities planned under this alternative technically feasible.<br>Long-term institutional management, monitoring, and 5-year reviews required. | No active reduction in MTV.<br>Groundwater and organic soil contaminants will naturally attenuate; therefore reducing the TV.<br>There will be no reduction in the MTV or the inorganic soil contaminants. | As groundwater contaminants naturally attenuate, the groundwat will meet ARARs and R<br>Soil will not meet ARAR RAOs due to the lead detection in excess of the Industrial Direct Contact Value. |
| 3-3<br>Clay Cap for Soil and In-situ (Soil Vapor Extraction) Soil Treatment and In-situ (Air Sparging) Groundwater Treatment | $364,400 - $780,800 | Will provide overall protection of human health and the environment.<br>Institutional controls will protect human health during the remediation activities. | Activities planned under this alternative are technically feasible.<br>Institutional management, monitoring, and a 5-year review required.<br>SVE and air sparge pilot tests required. | Groundwater treatment will reduce the MTV of groundwater contaminants. In addition, the SVE system will result in the reduction of the MTV of organic contaminants in the soil.<br>The clay cap will not reduce TV, but will reduce the M of the soil contaminants and prevent direct contact with the lead. | Will meet ARARs and R for groundwater and soil. |

**TABLE 4-6 (Continued)**
**Comparative Analysis of Remedial Alternatives for Site 3**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Estimated Cost[(a)] | Overall Protection of Human Health and the Environment | Implementability | Reduction of Toxicity, Mobility, and Volume | Compliance with ARA and RAOs |
|---|---|---|---|---|---|
| <u>3-4</u><br>Enhanced Volatilization and Soil Cap for Soil and Aboveground (Air Stripping) Groundwater Treatment | \$1,457,800 - \$3,123,800 | Will provide overall protection of human health and the environment.<br><br>Institution controls will protect human health during the remediation activities. | Activities planned under this alternative are readily implemented.<br><br>Institutional management, monitoring, and 5-year reviews required.<br><br>Pump test and bench scale test required. | Groundwater treatment will reduce the MTV of the groundwater contaminants.<br><br>Soil treatment will result in a reduction of the MTV of organic soil contaminants and the reduction of the M for the inorganic soil contaminants. | Groundwater and soil wi meet ARARs and RAOs under this alternative. |

(a) Present worth cost is calculated based on a 7 percent discount rate over the duration of the alternative.
(b) M=mobility, T=toxicity, V=volume

J:\4162\0110\WP\TAB4-6.DOC

**4.4.1.5 Reduction of Toxicity, Mobility, or Volume.** The no action alternative will not result in active reduction of toxicity, mobility, or volume of contaminants. There may be natural attenuation of groundwater and organic soil contaminants, however, the no action alternative will not provide any means of monitoring the attenuation of contaminants.

**4.4.1.6 Overall Protection of Human Health and the Environment.** The no action alternative will not be protective of human health or the environment. There will be no measures taken to prevent human contact with the soil contaminants in excess of the Industrial Direct Contact Values.

**4.4.1.7 Compliance with ARARs.** The no action does not meet ARARs for groundwater or soil.

**4.4.2 Alternative 3-2: Limited Action (Natural Attenuation, Monitoring, and Restrictions)** Under the limited action alternative, the soil and groundwater contaminants will not be contained or treated, but allowed to naturally attenuate. Institutional controls will be used to prevent human exposure to contaminated soils and to prevent the use of groundwater, as necessary. This alternative includes a fence around the bermed fire training area to prevent human contact with the soil contaminants in excess of the Industrial Direct Contact Value. Monitoring of groundwater will allow for an assessment of the natural attenuation to determine when the site no longer poses a threat to human health and the environment. It is anticipated that the limited action will require long-term use of institutional controls due to the ineffectiveness of natural attenuation of the lead in soil.

**4.4.2.1 Short-Term Effectiveness.** This alternative will achieve protection immediately. Institutional controls will be effective in preventing human exposure to soil and groundwater contaminants. There would be no additional environmental contamination caused by this alternative. The installation of the fence should not pose a threat to either the fence installers or the community. Soil contaminants at Site 3 include PCE, benzene, trimethylbenzene, antimony,

cadmium, chromium, copper, lead, and zinc. Organics such as benzene and trimethylbenzene will readily bio-degrade. PCE will likely attenuate through volatilization and bio-degradation.

There are no current groundwater users and institutional controls will prevent future use. The BETX and trimethylbenzene detected in the groundwater samples in excess of the Industrial Drinking Water Values, are bio-degradable and will not pose a problem with migration off-site before reaching levels below Residential Drinking Water Values. The antimony in the groundwater is not considered mobile in groundwater containing iron and dissolved oxygen. Oxygen and iron are both present in the groundwater at Kellogg and under most conditions will cause a low solubility precipitate to form with antimony which will not migrate. The cis-1,2-DCE detected in the groundwater samples is likely a breakdown product of the PCE in the soil. Degradation of chlorinated organics in groundwater does occur but at a much slower rate than BETX or trimethylbenzene. Diffusion and dispersion are expected to contribute to the attenuation of the cis-1,2-DCE.

Natural attenuation will occur for organic contaminants in the soil. Chlorinated organic compounds are expected to degrade very slowly; however, they will also attenuate through volatilization into the unsaturated pore spaces in the soil and migrate to the surface. Continued sampling of groundwater will provide information to monitor the natural attenuation of contaminants at the sites.

Inorganic contaminants in the soil will not attenuate. Natural attenuation of the contaminants in groundwater and soils could potentially take 20 to 30 years. Since some of the soil contaminants are likely the source of contaminants in the groundwater, it is unlikely that the groundwater will meet ARARs until soil contaminants are fully attenuated.

**4.4.2.2 Long-Term Effectiveness.** Human exposure through direct contact with soil contaminants will be reduced with the use of a fence around the contaminated soils. Experience has shown that inorganic contaminants in soil do not naturally attenuate. Therefore, it is not expected that these contaminants will attenuate below the ARARs. Antimony and other metals

detected above background in soil samples will not attenuate. If the metals detected in the soil are shown to leach to the groundwater, the soils will not meet ARARs or RAOs. It is expected that groundwater contaminants and organic soil contaminants will naturally attenuate, meeting groundwater ARARs and RAOs. Five-year reviews will be necessary to determine when site contaminants have decreased to below ARARs.

**4.4.2.3 Implementability.** Technical and administrative feasibility of Alternative 3-2 and the availability of the goods and services needed to implement the alternative are as follows:

**4.4.2.3.1 Technical Feasibility.** Site activities planned under this alternative are technically feasible. The groundwater monitoring, fence installation, and five-year reviews required for this alternative can be implemented.

**4.4.2.3.2 Administrative Feasibility.** Long-term institutional management will be associated with this alternative due to the lead detection in the soil. It is expected that the MIANG will be able to implement and enforce the required institutional controls for Site 3.

**4.4.2.3.3 Availability of Services and Materials.** Contractor services are readily available to install fencing, complete the groundwater monitoring, and complete the five-year reviews.

**4.4.2.4 Cost.** The cost associated with this alternative is presented in Table 4-7. Assuming a 7 percent discount rate, the 30-year, present-worth cost for this alternative is $163,800 (plus 50% to minus 30%).

**4.4.2.5 Reduction of Toxicity, Mobility, or Volume.** The limited action alternative will not actively reduce the toxicity, mobility, and volume of the soil or groundwater contaminants. As natural attenuation occurs, there will be a reduction in the toxicity, volume, and mobility of groundwater contaminants and organic soil contaminants as discussed in the Short Term

**TABLE 4-7**
**Cost Estimate for Alternative 3-2: Limited Action**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS (DDC)** | | | | |
| Institutional Controls (Note 1) | 1 | lump sum | | $15,000 |
| PRE-DESIGN ACTIVITIES | | | | |
| Work Plans/Sampling Plans (Note 11) | 1 | lump sum | | $4,000 |
| Soil Investigation (Note 2) | 1 | lump sum | | $10,000 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Contingency (Note 1) | 1 | lump sum | | $5,000 |
| | *TOTAL CAPITAL COSTS* | | | $34,000 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 4) | 1 | yearly | | $9,500 |
| | *TOTAL ANNUAL COSTS* | | | $9,500 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEWS | | | | |
| Planning | 1 | lump sum | | $500 |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $3,500 |
| Report Preparation | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 30 | | | |
| | *TOTAL PRESENT WORTH* | | | $163,754 |

Notes refer to assumptions used in the preparation of the cost estimate. All notes are listed in Appendix A-2.

Effectiveness Section 4.4.2.1. This alternative will not result in the reduction of the mobility, toxicity, or volume of inorganic contaminants in the soil.

**4.4.2.6 Overall Protection of Human Health and the Environment.** This alternative will offer a higher level of protection than Alternative 3-1 because it will reduce the potential for human contact with or ingestion of soil contaminants. There will be a potential for worker contact with the contaminants during maintenance activities such as mowing. The use of institutional controls to prevent groundwater use will eliminate the potential ingestion or contact with groundwater contaminants. This alternative will not protect environmental receptors (i.e., birds and small animals) from potential exposure to soil contaminants.

**4.4.2.7 Compliance with ARARs.** As the contaminants in the groundwater naturally attenuate, the groundwater will meet ARARs. However, if the inorganic contaminants are leaching to groundwater the inorganic contaminants in groundwater may never attenuate to levels below the Industrial Drinking Water Value. Organic contaminants in soil will attenuate and meet ARARs. It is not expected that lead contaminated soils will attenuate to levels meeting the Industrial Direct Contact ARARs. Therefore, it is not expected that the soil will meet ARARs.

### 4.4.3 Alternative 3-3: Clay Cap and In-Situ Soil Treatment (Soil Vapor Extraction) for Soil and In-situ Groundwater Treatment (Air Sparging)

Alternative 3-3 will include a clay cap for the soil contaminants to prevent leaching of the soil contaminants and to prevent dermal contact with lead contaminated soil. Volatile organic contaminants will be removed from the soil using SVE. This alternative will also include treatment of the groundwater contaminants by air sparging. SVE and air sparging pilot tests will be conducted to provide necessary design information.

This alternative will include institutional controls to prevent human exposure to lead contaminated soil and to prevent the use of groundwater until the remedial actions are completed for this alternative. Annual groundwater monitoring will be used to evaluate the remedial progress. A five-year review will be completed as part of this alternative

**4.4.3.1 Short-Term Effectiveness.** This alternative will provide immediate protection of human health and the environment. The clay cap provides protection for human contact with lead above the Industrial Direct Contact Values. The cap will also effectively prevent metals and organics in the soils from leaching to the groundwater. Preparation of the existing bermed fire training area for the cap may produce minor amounts of fugitive dust over a short time. This dust should pose no threat to the community, but may pose a minor threat to remedial action workers. Protection of workers will be achieved with proper protective clothing and masks and by spraying the soil with water to subdue dust production.

SVE will remove volatile organic contaminants (BETX, PCE, and trimethylbenzene). Once removed, these contaminants will not pose a threat of leaching to the groundwater.

There are no current groundwater users and institutional controls will prevent future use. Air sparging will remove the volatile contaminants from the groundwater. Antimony in the groundwater will become immobile due to oxygen enhanced iron coprecipitation. The SVE system will collect the sparge air and send it through a treatment system (carbon adsorption), if required.

Clay cap installation can be completed within one year. The moderate levels of contaminants in the groundwater and soil will require approximately five years to remediate.

**4.4.3.2 Long-Term Effectiveness.** The clay cap will provide effective protection against contact with soil contaminants above the Industrial Direct Contact Values, due to the isolation of the soil afforded by the clay cap. The clay cap will provide long-term protection against soil contaminants being leached by natural infiltration. Clay caps have an expected life of 20 to 30 years before requiring repair. Air sparging will effectively treat and remove or immobilize the groundwater contaminants detected at Site 3. SVE will effectively remove of the organic soil contaminants detected at Site 3. The likely source of the soil and groundwater contaminants is past fire training operations at the base. It is anticipated that as the organic soil contaminants are removed, the

source of the organic groundwater contaminants will also be removed. A five year review will be required to assess the remediation and condition of site soils and groundwater.

**4.4.3.3 Implementability.** Technical and administrative feasibility of Alternative 3-3 and the availability of the goods and services needed to implement the alternative are as follows:

**4.4.3.3.1 Technical Feasibility.** Site activities planned under this alternative are technically feasible. The groundwater monitoring, clay cap, air sparging, and the five-year review required for this alternative can be implemented.

**4.4.3.3.2 Administrative Feasibility.** Institutional management will be associated with this alternative while groundwater contaminants are being treated. It is expected that the MIANG will be able to implement and enforce the required institutional controls for these sites.

**4.4.3.3.3 Availability of Services and Materials.** Contractor services are readily available to complete the groundwater monitoring, to construct the cap, to complete the installation and O&M of the air sparging system, and to complete the five-year review.

**4.4.3.4 Cost.** The cost associated with this alternative is presented in Table 4-8. Assuming a 7 percent discount rate, the 30-year, present-worth cost for this alternative is $520,500 (plus 50% to minus 30%).

**4.4.3.5 Reduction of Toxicity, Mobility, or Volume.** The cap will not result in a reduction of the toxicity or volume of the inorganic contaminants in the soil. There will be a reduction in the mobility of the inorganic contaminants. The SVE system will result in the reduction of toxicity, mobility, and volume of the organic contaminants in the soils. The air sparging will result in the reduction of the toxicity, mobility, and volume of the organic contaminants in the groundwater. Air sparging will also result in the reduction of the mobility of inorganic contaminants, but will not reduce the toxicity or volume.

**TABLE 4-8**
**Cost Estimate for Alternative 3-3: Cap and In-situ Treatment of Soils and In-situ Groundwater Treatment**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS (DDC)** | | | | |
| Institutional Controls (Note 1) | 1 | lump sum | | $10,000 |
| PRE-DESIGN ACTIVITIES | | | | |
| Work Plans/Sampling Plans (Note 11) | 1 | lump sum | | $4,000 |
| SVE Pilot Test | 1 | lump sum | | $5,000 |
| Air Sparge Pilot Test | 1 | lump sum | | $10,000 |
| Soil Investigation (Note 2) | 1 | lump sum | | $10,000 |
| CLAY CAP FOR SOIL (Note 5) | | | | |
| Mobilization / Demobilization | 1 | lump sum | $1,000 | $1,000 |
| Site Grading (Including Material Placement) | 644 | cu yd | $5 | $3,220 |
| Cap | 967 | sq. yd. | $13 | $12,571 |
| Reseed/Fertilize | 0.2 | acre | $2,650 | $530 |
| SOIL VAPOR EXTRACTION and AIR SPARGING GROUNDWATER TREATMENT ( Equipment and Construction Cost) (Note 5) | | | | |
| Capital Equipment Costs | 1 | lump sum | $41,000 | $41,000 |
| Mechanical Installation | 1 | lump sum | $35,750 | $35,750 |
| Electrical Installation | 1 | lump sum | $9,000 | $9,000 |
| Building Installation | 1 | lump sum | $15,000 | $15,000 |
| Sparge Well Installation | 20 | wells | $1,600 | $32,000 |
| SVE Well Installation | 10 | wells | $1,000 | $10,000 |
| Trenching and Piping Installation | 500 | ft | $20 | $10,000 |
| Mobilize/Demobilize (15% or remediation direct capital cost)(Note 13) | | | | $10,454 |
| | *DIRECT CAPITAL COSTS (DDC)* | | | $219,525 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Engineering | | 6% of DDC | | $13,171 |
| Permitting | | 8% of DDC | | $17,562 |
| Construction Oversight/Tech. Support | | 15% of DDC | | $32,929 |
| Contingency | | 20% of DDC | | $43,905 |
| | *INDIRECT CAPITAL COSTS* | | | $107,567 |
| | *TOTAL CAPITAL COSTS* | | | $327,092 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 4) (5 years) | 1 | yearly | | $9,500 |
| CAP MAINTENANCE | | | | |
| Maintenance Costs (Note 6) (30 years) | 1 | yearly | | $1,500 |
| TREATMENT SYSTEM | | | | |
| Treatment Costs (Note 7) ( 5 years) | 1 | yearly | | $13,500 |
| Maintenance Costs (Note 8) (5 years) | 1 | yearly | | $16,750 |
| | *TOTAL ANNUAL COSTS* | | | $41,250 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEW | | | | |
| Planning | 1 | lump sum | | $500 |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $3,500 |
| Report Preparation | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 30 | | | |
| | *TOTAL PRESENT WORTH* | | | $520,549 |

Notes refer to assumptions used in the preparation of the cost estimate. All notes are listed in Appendix A-2.

**4.4.3.6 Overall Protection of Human Health and the Environment.** Human health and the environment will be protected by this alternative by eliminating the potential for contact with soil and groundwater contaminants. The clay cap will prevent human contact with lead and will effectively prevent the metals in soils from contaminating the groundwater. Once groundwater remediation is complete and the cap has been proven effective, the institutional controls for groundwater can be removed.

**4.4.3.7 Compliance with ARARs.** Once the cap is installed over the soil contaminants and institutional controls are in place to prevent future excavation, this alternative will meet ARARs for the inorganic soil contaminants. When SVE has decreased the organic contaminants to a level at which they will not leach to the groundwater, this alternative will meet ARARs for organic contaminants in soil. Air sparging will reduce groundwater contaminants to levels that meet all ARARs.

### 4.4.4 Alternative 3-4: Enhanced Volatilization, Soil Stabilization, and Soil Cap for Soils and Aboveground Groundwater Treatment (Air Stripping and Ion Exchange)

Alternative 3-4 will use enhanced volatilization to remove volatile organic contaminants from the soil to prevent future leaching of the contaminants to the groundwater. Contaminated soils will be excavated for treatment by enhanced volatilization. Soils with metals in excess of the Calculated Background Values will be solidified with the addition of Portland cement. Once treated, the excavated soil will be used as backfill. Soils with lead concentrations in excess of the Industrial Direct Contact Criteria will be placed at least 18 inches below the finished grade surface. The top 18 inches will be soils without contaminants in excess of the Industrial Direct Contact Value. This top 18 inches will act as a soil cap preventing human and small animal contact with soils in excess of the Industrial Direct Contact Values. This alternative will also include aboveground groundwater treatment of the groundwater contaminants by air stripping (for organic contaminants) and ion exchange (for inorganic contaminants). A pump test and a bench scale test will be completed to provide necessary design information.

This alternative will include institutional controls to prevent human exposure to lead contaminated soil and to prevent the use of groundwater until the remedial actions are completed for this alternative. Annual groundwater monitoring will be used to evaluate the remedial progress. A five-year review will be completed as part of the alternative.

**4.4.4.1 Short-Term Effectiveness.** This alternative will provide immediate protection of human health and the environment. Excavation of the existing bermed fire training area for treatment by enhanced volatilization and stabilization may produce minor amounts of fugitive dust over a short time. This dust should pose no threat to the community, but may pose a minor threat to remedial action workers. Protection of workers will be achieved with proper protective clothing and masks and by spraying the soil with water to subdue dust production. Enhanced volatilization will remove volatile organic contaminants (BETX, PCE, and trimethylbenzene) from the subsurface soil. Treatment of the off-gas will be performed if necessary to comply with the air discharge permit.

There are no current groundwater users, and institutional controls will prevent future use of the groundwater. Air stripping will remove the volatile organic contaminants from the groundwater. Antimony in the groundwater will be removed by ion exchange.

Annual groundwater monitoring will be used to evaluate the remedial progress. Five-year reviews will be completed as part of this alternative.

Enhanced Volatilization of soils can be completed within one year. The moderate levels of contaminants in the groundwater will require approximately 10 years to remediate. Extraction of groundwater is not as efficient as in-situ methods for removal of contaminants of concern from the groundwater.

**4.4.4.2 Long-Term Effectiveness.** This alternative will provide effective protection against contact with soil contaminants above the Industrial Direct Contact Values. Soils with inorganic contaminants above Calculated Background Values will be prevented from leaching by soil

stabilization. Enhanced volatilization will remove the leachable organic contaminants in the soil. Air stripping and ion exchange will effectively treat and remove all the groundwater contaminants detected at Site 3. The likely source of the soil and groundwater contaminants is past fire training operations at the site. It is anticipated that as the organic soil contaminants are removed and the inorganic contaminants are stabilized, the source of the groundwater contaminants will also be removed. Five-year reviews will be required to assess the remediation and condition of site groundwater.

**4.4.4.3 Implementability.** Technical and administrative feasibility of Alternative 3-4 and the availability of the goods and services needed to implement the alternative is as follows:

**4.4.4.3.1 Technical Feasibility.** Site activities planned under this alternative are technically feasible. The groundwater monitoring, enhanced volatilization, soil stabilization, groundwater treatment system, and five-year reviews required for this alternative can be implemented.

**4.4.4.3.2 Administrative Feasibility.** Long-term institutional management will be associated with this alternative while groundwater contaminants are being treated. It is expected that the MIANG will be able to implement and enforce the required institutional controls for these sites.

**4.4.4.3.3 Availability of Services and Materials.** Contractor services are readily available to complete the continued groundwater monitoring, to excavate soils, to perform the enhanced volatilization, to perform the stabilization, to complete the installation and O&M of the groundwater treatment system, and to complete the five-year reviews.

**4.4.4.4 Cost.** The cost associated with this alternative is presented in Table 4-9. Assuming a 7 percent discount rate, the 30-year, present-worth cost for this alternative is $2,082,500 (plus 50% to minus 30%).

**TABLE 4-9**
**Cost Estimate for Alternative 3-4: Cap of Soils and Aboveground Groundwater Treatment**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS (DDC)** | | | | |
| Institutional Controls (a) | 1 | lump sum | | $10,000 |
| PRE-DESIGN ACTIVITIES | | | | |
| Work Plans/Sampling Plans (Note 12) | 1 | lump sum | | $7,000 |
| Bench Scale Test/Pump Test | 1 | lump sum | | $17,000 |
| Soil Investigation (Note 2) | 1 | lump sum | | $10,000 |
| ENHANCED VOLATILIZATION, SOIL STABILIZATION and SOIL CAP | | | | |
| Excavation and Backfill | 29475 | tons | $14 | $412,650 |
| Enhanced Volatilization | 29475 | tons | $15 | $442,125 |
| Additive for Stabilization | 480 | tons soil | $8 | $3,840 |
| Topsoil for Soil Cap (including grading) | 330 | cu. yd | $18 | $5,940 |
| Reseed/Fertilize | 0.4 | acre | $2,650 | $1,087 |
| ABOVEGROUND GROUNDWATER TREATMENT ( Equipment and Construction Cost) (Note 5) | | | | |
| Air Stripping and Ion Exchange Packages | 1 | lump sum | $128,500 | $128,500 |
| Mechanical Installation | 1 | lump sum | $19,400 | $19,400 |
| Electrical Installation | 1 | lump sum | $8,000 | $8,000 |
| Building Installation | 1 | lump sum | $15,000 | $15,000 |
| Extraction Well Installation | 3 | well | $4,000 | $12,000 |
| Injection Well Installation | 1 | well | $2,000 | $2,000 |
| Trenching and Underground Piping | 300 | ft | $36 | $10,800 |
| Mobilize/Demobilize (5% of remediation direct capital cost)(Note 13) | | | | $55,267 |
| | *DIRECT CAPITAL COSTS (DDC)* | | | $1,160,609 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Engineering | | 6% of DDC | | $69,637 |
| Permitting | | 8% of DDC | | $92,849 |
| Construction Oversight/Tech. Support | | 15% of DDC | | $174,091 |
| Contingency | | 20% of DDC | | $232,122 |
| | *INDIRECT CAPITAL COSTS* | | | $568,698 |
| | *TOTAL CAPITAL COSTS* | | | $1,729,307 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 4) (10 years) | 1 | yearly | | $9,500 |
| CAP MAINTENANCE | | | | |
| Maintenance Costs (Note 6) (30 years) | 1 | yearly | | $500 |
| GROUNDWATER TREATMENT | | | | |
| Treatment Costs (Note 7) (10 years) | 1 | yearly | | $8,395 |
| Influent/Effluent Monitoring (Note 10) ( 10 years) | 1 | yearly | | $9,575 |
| Maintenance Costs (Note 8) (10 years) | 1 | yearly | | $20,250 |
| | *TOTAL ANNUAL COSTS* | | | $47,720 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEW | | | | |
| Planning | 1 | lump sum | | $500 |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $3,500 |
| Report Preparation | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 30 | | | |
| | *TOTAL PRESENT WORTH* | | | $2,082,546 |

Notes refer to assumptions used in the preparation of the cost estimate. All notes are listed in Appendix A-2.

**4.4.4.5 Reduction of Toxicity, Mobility, or Volume.** Enhanced volatilization of the soils will result in the reduction of the toxicity, mobility, and volume of the organic contaminants in the soils. The soil stabilization will reduce the mobility of the inorganic soil contaminants, but not the toxicity or volume. Air stripping and ion exchange will result in the reduction of the toxicity, mobility, and volume of the contaminants in the groundwater.

**4.4.4.6 Overall Protection of Human Health and the Environment.** Human health and the environment will be protected by this alternative by eliminating the potential for contact with contaminants in the soils and groundwater by humans or small animals. Once remedial actions are complete for groundwater and soil, the institutional controls related to contaminated groundwater will be removed.

**4.4.4.7 Compliance with ARARs.** Once the inorganic contaminants above the Industrial Direct Contact Values are no longer at the surface, the cap is covering the contaminants, and institutional controls prevent future excavation, this alternative will meet ARARs for direct contact of soils. When the enhanced volatilization process decreases the concentration of the organic contaminants in the soil to a level that will not leach from the soil and soil stabilization prevents inorganic contaminants from leaching, this alternative will meet all ARARs applicable to the soils. Air stripping and ion exchange will reduce groundwater contaminants to levels that meet all chemical specific ARARs.

### 4.4.5 Comparison of Alternatives for Site 3

In this section, alternatives for Site 3 are compared to each other. The purpose of this analysis is to evaluate the relative advantages and disadvantages between different alternatives.

**4.4.5.1 Short-Term Effectiveness.** All alternatives except Alternatives 3-1 provide short-term effectiveness in the protection of human health and the environment. Alternatives 3-3 and 3-4 present a slight threat to remedial workers due to disturbance of contaminated soils, but this can be minimized through standard health and safety precautions.

**4.4.5.2 Long-Term Effectiveness.** Alternatives 3-1 and 3-2 will provide no assurance of long-term effectiveness. Alternatives 3-3 and 3-4 provide long-term protection for the lead in excess of the Industrial Direct Contact Value. Alternatives 3-3 and 3-4 will provide permanent protection of the groundwater by removing or stabilizing the contaminants from the soils. Alternative 3-2 will provide long-term protection of the groundwater by decreasing contaminants through natural attenuation. Only Alternatives 3-3 and 3-4 will meet all soil and groundwater RAOs.

**4.4.5.3 Implementability.** All alternatives are technically and administratively feasible. All materials for all alternatives are readily available.

**4.4.5.4 Cost.** Costs for each alternative are present in Table 4-6.

**4.4.5.5 Reduction of Toxicity, Mobility, Volume.** Alternative 3-1 will have no active effect on the mobility, toxicity, or volume of the contaminants. Alternative 3-3 will result in the reduction of the mobility of soil contaminants through the use of a clay cap. Alternative 3-4 will result in the reduction of the mobility of the inorganic soil contaminants through the use of soil stabilization. Neither Alternative 3-3 or 3-4 will reduce the toxicity or volume of inorganic soil contaminants. In time, Alternative 3-2 will reduce the toxicity or volume of the groundwater and organic soil contaminants through natural attenuation. Alternatives 3-3 and 3-4 will result in the reduction of the toxicity, mobility, or volume of the groundwater and organic soil contaminants.

**4.4.5.6 Overall Protection of Human Health and the Environment.** All of the alternatives except Alternative 3-1 provide immediate protection of human health. Alternative 3-1 and 3-2 make no provisions for the protection of environmental receptors (i.e., birds, etc.) from soil contaminants. Alternatives 3-3 and 3-4 provide long-term protection of human health and the environment.

**4.4.5.7 Compliance with ARARs.** Only Alternatives 3-3 and 3-4 will meet ARARs for inorganic soil contaminants. After active remediation is complete for groundwater and soils at Site 3,

Alternatives 3-3 and 3-4 will meet ARARs. Alternative 3-2 will meet ARARs for organic contaminants in the groundwater and soil after natural attenuation has taken place.

## 4.5 DETAILED ANALYSIS FOR AREA OF CONCERN A

Remedial action alternatives for AOC A soil are presented below. There has been no groundwater investigation completed at this site. A groundwater investigation is necessary at AOC A to determine if the soil contaminants are leaching to the groundwater. The following alternatives address only soil contaminants. Table 4-10 summarizes the result of the analysis of AOC A alternatives.

### 4.5.1 Alternative A-1: No Action

The no action alternative serves as a baseline for comparison with other remedial alternatives. Under this alternative, no remedial actions will be performed at AOC A to contain or reduce the contaminants in soil and groundwater. An assessment of Alternative A-1 follows:

**4.5.1.1 Short-Term Effectiveness.** This alternative provides no protection of human health or the environment, therefore, the RAOs will not be met. This alternative would not produce any additional environmental contamination and there would be no additional threats to the surrounding community since there is no disturbance of the site. None of the contaminants in surface soils are in excess of the Industrial Direct Contact Values.

**4.5.1.2 Long-Term Effectiveness.** The long-term effectiveness and permanence of this alternative is not known. Without groundwater data it is unknown whether the soils meet ARARs or RAOs.

**4.5.1.3 Implementability.** No action is required for implementation of this alternative. No services will be required to implement this alternative.

**4.5.1.4 Costs.** There will be no cost associated with this alternative.

**TABLE 4-10**
**Comparative Analysis of Remedial Alternatives for Area of Concern A**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Estimated Cost[a] | Overall Protection of Human Health and the Environment | Implementability | Reduction of Toxicity, Mobility, and Volume | Compliance with ARARs and RAOs |
|---|---|---|---|---|---|
| **A-1**<br>No Action | $0 | No action may not be protective of human health or the environment.<br><br>No information will be available to determine if the soil contaminants are leaching to the groundwater. | No action to implement. | No active reduction in MTV[b] of soil contaminants. | Will not meet ARARs or RAOs for groundwater or soil, since no information will be available to show otherwise. |
| **A-2**<br>Limited Action (Natural Attenuation, Monitoring, and Restrictions) | $55,900 - $119,800 | Soil contaminants do not currently pose a human health concern.<br><br>If soil contaminants are determined to be leaching to groundwater institutional controls will prevent use of groundwater until levels attenuate and meet ARARs. | Activities planned under this alternative are technically feasible.<br><br>Long-term institutional management, monitoring, and 5-year reviews required. | There will be no active reduction in MTV.<br><br>The organic contaminants in the soil will naturally attenuate. The inorganic contaminants in the soil will not attenuate.<br><br>Possible organic contaminants to the groundwater will likely attenuate with time. | If soil contaminants are determined not to leach to groundwater, this alternative will meet groundwater and soil ARARs and RAOs.<br><br>If the soil contaminants are determined to be leaching to the soil, then this alternative may not meet groundwater and soil ARARs and RAOs, unless it is determined that the leaching contaminants will naturally attenuate to appropriate levels. |

**TABLE 4-10 (Continued)**
**Comparative Analysis of Remedial Alternatives for Area of Concern A**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| Alternative | Estimated Cost[a] | Overall Protection of Human Health and the Environment | Implementability | Reduction of Toxicity, Mobility, and Volume | Compliance with ARARs and RAOs |
|---|---|---|---|---|---|
| A-3<br>In-situ Stabilization/ Solidification for Soil | \$175,200 - \$375,400 | Will provide overall protection of human health and the environment relating to soil contaminants.<br>Institutional controls will protect human health during the remediation activities.<br>Institutional controls will also be effective in preventing groundwater use until the appropriate remediation is determined. | Activities planned under this alternative are technically feasible.<br>Institutional management, monitoring, and a 5-year review required.<br>Treatability study is required. | The stabilization/solidification will reduce the M of the soil contaminants, but will not reduce the TV of the soil contaminants.<br>This alternative will not reduce the MTV of the potential groundwater contaminants. Natural attenuation of the groundwater contaminants may occur and result in the reduction of the MTV of the potential groundwater contaminants. | The treated soils will meet ARARs and RAOs.<br>The groundwater will only meet ARARs and RAOs if it is determined that natural attenuation is effective on the constituents that leached from the soil to the groundwater. |
| A-4<br>Clay Cap for Soil | \$83,055 - \$177,975 | Will provide overall protection of human health and the environment relating to soil contaminants.<br>Institutional controls will protect human health during the remediation activities.<br>Institutional controls will also be effective in preventing groundwater use until the appropriate remediation is determined. | Activities planned under this alternative are readily implemented.<br>Institutional management, monitoring, and 5-year reviews required. | The cap will reduce the M of the soil contaminants, but will not reduce the TV of the soil contaminants.<br>This alternative will not reduce the MTV of the potential groundwater contaminants. Natural attenuation of the groundwater contaminants may occur and result in the reduction of the MTV of the potential groundwater contaminants. | The soils will meet ARARs and RAOs.<br>The groundwater will only meet ARARs and RAOs if it is determined that natural attenuation is effective on the contaminants that leached from the soil to the groundwater. |

(a) Present worth cost is calculated based on a 7 percent discount rate over the duration of the alternative.
(b) M=mobility, T=toxicity, V=volume

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**4.5.1.5 Reduction of Toxicity, Mobility, or Volume.** This alternative will not result in an active reduction of the mobility toxicity, or volume of contaminants in the soil. Organic contaminants in the soil will likely naturally attenuate reducing the mobility, toxicity, or volume of the organic contaminants. Inorganic contaminants in the soil will not naturally attenuate. There will be no reduction in the mobility, toxicity, or volume of the inorganic contaminants in the soil.

**4.5.1.6 Overall Protection of Human Health and the Environment.** No soil contaminants are above the Industrial Direct Contact Criteria and therefore are protective of human health and the environment with respect to direct contact with the soil. Without groundwater samples it unknown whether the soils are protective of groundwater.

**4.5.1.7 Compliance with ARARs.** Because there is no information to show that soil contaminants are not leaching, it can not be verified that this alternative meets ARARs.

### 4.5.2 Alternative A-2: Limited Action (Natural Attenuation, Monitoring, and Institutional Controls)

Under the limited action alternative, the soil contaminants will not be contained or treated, but allowed to naturally attenuate. Initially, this alternative will include the completion of a limited groundwater investigation to determine if the soil contaminants are leaching to the groundwater. If the soils are not leaching, then the site poses no human health or environmental concerns related to the soil contaminants.

In addition, this alternative will include continued monitoring of groundwater if the soils prove to be leaching to the groundwater. This will allow for an assessment of the natural attenuation of site contamination. Institutional controls may be required to prevent the future use of groundwater if the investigation indicates that the groundwater contains contaminants in excess of the Drinking Water Values.

**4.5.2.1 Short-Term Effectiveness.** Construction of additional monitoring wells can be implemented in a very short time. No additional threats are posed to the environment or the

community by the construction activities. There will be no threat to workers during the monitoring well installation. Natural attenuation of organic contaminants in the soil is anticipated to reduce the level of the contaminants to below ARARs. No natural attenuation of the inorganic contaminants is expected. Natural attenuation of organic contaminants to levels meeting RAOs should occur within ten years.

**4.5.2.2 Long-Term Effectiveness.** The long-term effectiveness and permanence of this alternative is unknown. A groundwater investigation will determine if and which soil contaminants are leaching to the groundwater. Natural attenuation is anticipated to remove the organic contaminants in the soil. Natural attenuation will not be effective on inorganic contaminants in soil. Five-year reviews will be necessary to assess the natural attenuation.

**4.5.2.3 Implementability.** Technical and administrative feasibility of Alternative A-2 and the availability of the goods and services needed to implement the alternative are as follows:

**4.5.2.3.1 Technical Feasibility.** Activities planned under this alternative are technically feasible. The groundwater investigation, continued groundwater monitoring, and five-year review required for this alternative can be implemented.

**4.5.2.3.2 Administrative Feasibility.** Long-term institutional management may be associated with this alternative because contaminants will remain on site. It is expected that the MIANG will be able to implement and enforce the required institutional controls for these sites.

**4.5.2.3.3 Availability of Services and Materials.** Contractor services are readily available to complete the monitoring well installation, continue groundwater monitoring, and complete the five-year review.

**4.5.2.4 Cost.** The cost associated with this alternative is presented in Table 4-11. Assuming a 7 percent discount rate, the 10-year, present-worth cost for this alternative is $79,800 (plus 50% to minus 30%).

**TABLE 4-11**
**Cost Estimate for Alternative A-2: Limited Action**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS (DDC)** | | | | |
| Institutional Controls (Note 1) | 1 | lump sum | | $15,000 |
| PRE-DESIGN ACTIVITIES | | | | |
| Work Plans/Sampling Plans (Note 8) | 1 | lump sum | | $4,000 |
| Well Installation (Note 2) | 1 | lump sum | | $4,000 |
| Groundwater Investigation (Note 3) | 1 | lump sum | | $5,500 |
| Soil Sampling (Note 4) | 1 | lump sum | | $1,000 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Contingency (Note 1) | 1 | lump sum | | $5,000 |
| | *TOTAL CAPITAL COSTS* | | | $34,500 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 5) | 1 | yearly | | $5,500 |
| | *TOTAL ANNUAL COSTS* | | | $5,500 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEWS | | | | |
| Planning | 1 | lump sum | | $500 |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $3,500 |
| Report Preparation | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 10 | | | |
| | *TOTAL PRESENT WORTH* | | | $79,847 |

Notes refer to assumptions used in the preparation of the cost estimate. All notes are listed in Appendix A-3.

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**4.5.2.5 Reduction of Toxicity, Mobility, or Volume.** The limited action alternative will not actively reduce the toxicity, mobility, and volume of the soil contaminants. Organic soil contaminants will naturally attenuate, and the toxicity, mobility, or volume will be reduced.

**4.5.2.6 Overall Protection of Human Health and the Environment.** The soil contaminants do not currently pose a threat to human health. Groundwater is not currently used at the base; institutional controls will eliminate the possibility of future use. Institutional controls for groundwater will only be required if the groundwater investigation determines that the groundwater has been contaminated by the soil contaminants.

**4.5.2.7 Compliance with ARARs.** If the soil contaminants are shown not to leach to the groundwater, then this alternative will meet ARARs for the soil. If the soil contaminants are leaching in excess of the Industrial Drinking Water Values, the soil and groundwater may not meet ARARs.

### 4.5.3 Alternative A-3: In-situ Stabilization/Solidification for Soil

Alternative A-3 will be appropriate if it is determined that the soil contaminants at AOC A are leaching to the groundwater. Leaching will be determined by performing a groundwater investigation. This alternative consists of stabilization/solidification treatment of the soils to prevent leaching. A treatability study will be conducted to provide necessary design information.

This alternative will include continued monitoring of the groundwater to assess the performance of the treatment technology. Institutional controls may be required to prevent the future use of groundwater if the groundwater investigation indicates that the groundwater contains contaminants in excess of the Industrial Drinking Water Values.

**4.5.3.1 Short-Term Effectiveness.** This alternative will include a groundwater investigation to determine if the soil contaminants are leaching to the groundwater. If contaminants are leaching, this alternative will prevent leaching of soil contaminants and provide protection of groundwater. Preparation of AOC A surface for the stabilization/solidification may produce minor amounts of

fugitive dust over a short time. This should pose no threat to the community, but may pose a minor threat to remedial action workers. Protection of workers will be achieved with proper protective clothing and masks and by spraying the soil with water to subdue dust. Stabilization/solidification of soils can be completed within one year.

**4.5.3.2 Long-Term Effectiveness.** The stabilized soil will provide long-term protection with low residual risk. There should be very little to no maintenance activities. Institutional controls will be employed to assure that stabilized/solidified soils are not disturbed. This alternative will meet all ARARs and RAOs for soil. One five year review will be necessary to assess the effectiveness of the stabilized/solidified soils.

**4.5.3.3 Implementability.** Technical and administrative feasibility of Alternative A-3 and the availability of the goods and services needed to implement the alternative are as follows:

**4.5.3.3.1 Technical Feasibility.** Site activities planned under this alternative are technically feasible. The groundwater investigation, continued groundwater monitoring, soil stabilization/solidification, and the five-year review required for this alternative can be implemented.

**4.5.3.3.2 Administrative Feasibility.** Long-term institutional management may be associated with this alternative because soil contaminants will remain on site. It is expected that the MIANG will be able to implement and enforce the required institutional controls for these sites.

**4.5.3.3.3 Availability of Services and Materials.** Construction materials are readily available for the soil solidification/stabilization. Contractor services are readily available to complete groundwater monitoring, the soil treatment, and the five-year review.

**4.5.3.4 Cost.** The cost associated with this alternative is presented in Table 4-12. Assuming a 7 percent discount rate, the 5-year, present-worth cost for this alternative is $250,300 (plus 50% to minus 30%).

**4.5.3.5 Reduction of Toxicity, Mobility, or Volume.** This alternative will not result in the reduction of toxicity or volume of soil contaminants. The mobility of the soil contaminants will be reduced through the stabilization/solidification.

**4.5.3.6 Overall Protection of Human Health and the Environment.** This alternative will provide protection of human health and the environment relating to soil contamination.

**4.5.3.7 Compliance with ARARs.** The stabilized/solidified soils will pass leaching tests, therefore the soils will meet ARARs.

### 4.5.4 Alternative A-4: Clay Cap for Soil

Alternative A-4 will be appropriate if it is determined that the soil contaminants at AOC A are leaching to the groundwater. Leaching will be determined by performing a groundwater investigation. This alternative consists of capping the contaminated soil area to prevent leaching.

This alternative will include continued monitoring of the groundwater to assess the performance of the cap. Institutional controls may be required to prevent the future use of groundwater if the groundwater investigation indicates that the groundwater contains contaminants in excess of the Industrial Drinking Water Values.

**4.5.4.1 Short-Term Effectiveness.** The clay cap will effectively prevent water infiltration from leaching soil contaminants to the groundwater. Installation of the clay cap may produce minor amounts of fugitive dust over a short time. This should pose no threat to the community, but may pose a minor threat to remedial action workers. Protection of workers will be achieved with proper protective clothing and masks and by spraying the soil with water to subdue dust. Stabilization/solidification of soils can be completed within one year. The clay cap could be

**TABLE 4-12**
**Cost Estimate for Alternative A-3: In-situ Stabilization/Solidification Soils**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS (DDC)** | | | | |
| Institutional Controls (Note 1) | 1 | lump sum | | $10,000 |
| PRE-DESIGN ACTIVITIES | | | | |
| Work Plans/Sampling Plans (Note 8) | 1 | lump sum | | $4,000 |
| Treatibility Study | 1 | lump sum | | $10,000 |
| Well Installation (Note 2) | 1 | lump sum | | $4,000 |
| Groundwater Investigation (Note 3) | 1 | lump sum | | $5,500 |
| Soil Sampling (Note 4) | 1 | lump sum | | $1,000 |
| SOIL SOLIDIFICATION (Note 6) | | | | |
| Solidification | 3060 | tons | $35 | $107,100 |
| Topsoil/Reseed/Fertilize | 0.23 | acre | $17,170 | $3,942 |
| Mobilize/Demobilize (5% of remediation direct cost)(Note 9) | | | | $7,277 |
| | *DIRECT CAPITAL COSTS (DDC)* | | | $152,819 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Engineering | | 6% of DDC | | $9,169 |
| Permitting | | 8% of DDC | | $12,226 |
| Construction Oversight/Tech. Support | | 15%of DDC | | $22,923 |
| Contingency | | 20% of DDC | | $30,564 |
| | *INDIRECT CAPITAL COSTS* | | | $74,881 |
| | *TOTAL CAPITAL COSTS* | | | $227,701 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 5) ( 4 years) | 1 | yearly | | $5,500 |
| | *TOTAL ANNUAL COSTS* | | | $5,500 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEW | | | | |
| Planning | 1 | lump sum | | $500 |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $3,500 |
| Report Preparation | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 5 | | | |
| | *TOTAL PRESENT WORTH* | | | $250,252 |

Notes refer to assumptions used in the preparation of the cost estimate. All notes are listed in Appendix A-3.

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constructed within a one year time period. Institutional controls will be effective in preventing future use of groundwater that is contaminated in excess of the Industrial Drinking Water Values.

**4.5.4.2 Long-Term Effectiveness.** The cap will provide long-term protection with low residual risk. However protection against leaching would not be permanent. Clay caps have design lives of 20 to 30 years, after which repair or replacement may be necessary. Maintenance activities will consist of periodic mowing of vegetation and removal of woody plants or trees to prevent root damage to the clay layer. This alternative meets ARARs and RAOs for soil. Five-year reviews will be required to assess the groundwater.

**4.5.4.3 Implementability.** Technical and administrative feasibility of Alternative A-4 and the availability of the goods and services needed to implement the alternative are as follows:

**4.5.4.3.1 Technical Feasibility.** Site activities planned under this alternative are technically feasible. The groundwater investigation, continued groundwater monitoring, clay cap construction, and five-year reviews required for this alternative can be implemented.

**4.5.4.3.2 Administrative Feasibility.** Long-term institutional management may be associated with this alternative because contaminants will remain on site. It is expected that the MIANG will be able to implement and enforce the required institutional controls for these sites.

**4.5.4.3.3 Availability of Services and Materials.** Construction materials are readily available for the clay cap. Contractor services are readily available to complete the groundwater monitoring, install the clay cap, maintain the cap, and complete the five-year reviews.

**4.5.4.4 Cost.** The cost associated with this alternative is presented in Table 4-13. Assuming a 7 percent discount rate, the 30-year, present-worth cost for this alternative is $118,700 (plus 50% to minus 30%).

**TABLE 4-13**
**Cost Estimate for Alternative A-4: Clay Cap for Soils**
**110th Fighter Group (Kellogg)**
**Battle Creek, Michigan**

| ITEM/DESCRIPTION | QUANTITY | UNIT | UNIT COST | TOTAL COST |
|---|---|---|---|---|
| **CAPITAL COSTS** | | | | |
| **DIRECT CAPITAL COSTS (DDC)** | | | | |
| Institutional Controls (Note 1) | 1 | lump sum | | $10,000 |
| PRE-DESIGN ACTIVITIES | | | | |
| Work Plans/Sampling Plans (Note 8) | 1 | lump sum | | $4,000 |
| Well Installation (Note 2) | 1 | lump sum | | $4,000 |
| Groundwater Investigation (Note 3) | 1 | lump sum | | $5,500 |
| Soil Sampling (Note 4) | 1 | lump sum | | $1,000 |
| CLAY CAP FOR SOIL (Note 6) | | | | |
| Site Grading (Including Material Placement) | 1,667 | cu yd | $5 | $8,335 |
| Cap | 1667 | sq yd | $13 | $21,671 |
| Reseed/Fertilize | 0.23 | acre | $2,650 | $608 |
| Mobilize/Demobilize (5% of remediation direct capital)(Note 9) | | | | $2,756 |
| | *DIRECT CAPITAL COSTS (DDC)* | | | $57,870 |
| **INDIRECT CAPITAL COSTS** | | | | |
| Engineering | | 6% of DDC | | $3,472 |
| Permitting | | 8% of DDC | | $4,630 |
| Construction Oversight/Tech. Support | | 15% of DDC | | $8,681 |
| Contingency | | 20% of DDC | | $11,574 |
| | *INDIRECT CAPITAL COSTS* | | | $28,356 |
| | *TOTAL CAPITAL COSTS* | | | $86,227 |
| **ANNUAL O&M COSTS** | | | | |
| MONITORING | | | | |
| Groundwater Monitoring (Note 5) (5 years) | 1 | yearly | | $3,500 |
| CAP MAINTENANCE | | | | |
| Maintenance Costs (Note 7) (30 years) | 1 | yearly | | $500 |
| | *TOTAL ANNUAL COSTS* | | | $4,000 |
| **FIVE-YEAR COSTS** | | | | |
| SITE REVIEW | | | | |
| Planning | 1 | lump sum | | $500 |
| Site Assessment & Review of Monitoring Data | 1 | lump sum | | $3,500 |
| Report Preparation | 1 | lump sum | | $1,500 |
| | *FIVE YEAR REVIEW COSTS* | | | $5,500 |
| **PRESENT WORTH** | | | | |
| Interest Rate | 7% | | | |
| Replacement Interval | 30 | | | |
| | *TOTAL PRESENT WORTH* | | | $118,650 |

Assumption for cost estimate are located in Appendix A-3.

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**4.5.4.5 Reduction of Toxicity, Mobility, or Volume.** This alternative will not result in the reduction of toxicity or volume of soil contaminants. The mobility of the soil contaminants will be reduced by reducing infiltration of water through the soil.

**4.5.4.6 Overall Protection of Human Health and the Environment.** Public health and the environment will be protected under current use and potential future uses by reducing the potential for water to leach soil contaminants.

**4.5.4.7 Compliance with ARARs.** Soils under a clay cap will be protective of groundwater therefore meeting ARARs.

### 4.5.5 Comparison of Alternatives for Area of Concern A

In this section alternatives are compared in relation to each other for the criteria evaluated in individual alternative analysis. The purpose of this analysis is to evaluate the relative advantages and disadvantages between different alternatives.

**4.5.5.1 Short-Term Effectiveness.** All alternatives except A-1 provide short-term effectiveness in the protection of human health and the environment from soil contaminants. Alternatives A-3, and A-4 present a slight threat to remedial workers due to disturbance of contaminated soils, but this would be minimized through standard health and safety precautions.

**4.5.5.2 Long-Term Effectiveness.** Without site groundwater data it is not possible to accurately predict if soil contaminants will leach to the groundwater. Assuming soil contaminants are leaching to groundwater, Alternative A-3 is effective in preventing leaching to the groundwater in the long-term. The life-time of a clay cap is expected to be 20 to 30 years and therefore, will need repair in the long-term to maintain effectiveness. Alternative A-2 will be effective in the long-term for leaching contaminants that are organic in nature. Alternative A-2 is not effective in the long-term for the leaching of metals from soils. Alternative A-1 will be ineffective for soils with contaminants that leach.

**4.5.5.3 Implementability.** All alternatives are technically and administratively feasible. All materials for all alternative are readily available.

**4.5.5.4 Cost.** Costs for each alternative are present in Table 4-10.

**4.5.5.5 Reduction of Toxicity, Mobility, Volume.** Alternative A-1 will have no active effect on the mobility, toxicity, or volume of the contaminants. In time, Alternative A-2 will reduce the toxicity or volume of the organic contaminants in soil through natural attenuation. Alternative A2 will have no effect on inorganic contaminants in the soil. Alternatives A-3 and A-4 will reduce the mobility of the soil contaminants, but will not effect the toxicity or volume of the contaminants.

**4.5.5.6 Overall Protection of Human Health and the Environment.** All alternatives provide immediate protection of human health and the environment if soils contaminants are determined not to leach. If organic contaminants leach from soils, then Alternatives A-2, A-3, and A-4 will provide protection of human health and the environment. If inorganic contaminants leach from soils, then only A-3 and A-4 would provide protection for human health and the environment.

**4.5.5.7 Compliance with ARARs.** Only Alternatives A-3, and A-4 will meet ARARs for soils. Alternative A-2 will meet ARARs for soil if the groundwater investigation shows that the soil contaminants are not leaching to the groundwater or that only organic contaminants leach. Alternative A-1 will not comply with ARARs.

# 5.0 RECOMMENDED ALTERNATIVES

This section presents the recommended remedial alternatives for Site 1 and AOC B, Site 3, and AOC A.

## 5.1 SITE 1 AND AREA OF CONCERN B

The recommended remedial alternative for Site 1 and AOC B consists of constructing a soil cap over contaminated soil and natural attenuation for contaminated groundwater. The soil cap will provide dermal protection from lead contaminated soil. The relatively minor contamination in the groundwater will be effectively treated through natural attenuation. No sources were identified in previous reports for the groundwater contaminants; therefore, it is anticipated that the concentrations of these contaminants will naturally decrease over time and no longer pose a threat to human health or the environment. As the site groundwater is not currently used for a drinking water source (and is not expected to be used as such in the future), natural attenuation is considered appropriate for groundwater contamination at this site.

Remedial alternatives that were considered but are not recommended for use are discussed below:

- No Action. The No Action alternative would not provide dermal protection from lead contaminated soil.

- Limited Action for Groundwater and Soil (Natural Attenuation, Monitoring, and Restrictions). This alternative, similar to the recommended alternative, addresses groundwater through natural attenuation. However, this alternative would not provide dermal protection against lead contaminated soil.

- Soil Cap for Soil and In-Situ Groundwater Treatment and Soil Cap for Soil and Aboveground Treatment for Groundwater. These alternatives would provide the same protection as the recommended alternative but would cost substantially more.

## 5.2 SITE 3

The recommended remedial alternative for Site 3 consists of constructing a clay cap and an in-situ treatment system (soil vapor extraction and air sparging) to address contaminated soil and groundwater. The clay cap will provide dermal protection from the lead contaminated soil and prevent leaching of inorganic soil contaminants to the groundwater. The soil vapor extraction (SVE) system will remove organic contaminants from the soil to prevent leaching to the groundwater. This will allow for effective groundwater treatment without further leaching of contaminants to the groundwater. Air sparging, combined with SVE, will accelerate the removal of the organic contaminants from the groundwater.

Remedial alternatives that were considered but are not recommended for use are discussed below.

- No Action. The No Action alternative would not provide dermal protection against lead contaminated soil. The No Action alternative would not address groundwater contamination.

- Limited Action for Groundwater and Soil (Natural Attenuation, Monitoring, and Restrictions). It is unlikely that natural attenuation would decrease the levels of contaminants in the soil fast enough to prevent further groundwater contamination. Additionally, this alternative would provide less dermal protection against lead contaminated soils than would the recommended alternative.

- Enhanced Volatilization and Soil Cap for Soil and Aboveground Groundwater Treatment (Air Stripping). This alternative would provide the same protection as the recommended alternative but would cost substantially more.

## 5.3 AREA OF CONCERN A

The recommended remedial alternative for AOC A consists of natural attenuation, monitoring, and institutional controls. This alternative will include the installation of two monitoring wells to evaluate/monitor possible groundwater contamination.

Remedial Alternatives that were considered but are not recommended are discussed below.

- No Action. The No Action alternative would not provide for a means of investigating possible contamination in the groundwater. This alternative would not meet ARARs or RAOs.

- In-situ Stabilization/Solidification for Soil. This alternative would provide for long-term protection of the groundwater by preventing soil contaminants from leaching. However, at this point it has not been determined if soil contaminants are leaching (i.e., active groundwater remediation may be unnecessary).

- Clay Cap for Soil. Similar to the In-Situ Stabilization/Solidification, this alternative would provide protection of the groundwater that may be unnecessary.

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## 6.0 REFERENCES

U.S. Environmental Protection Agency, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.*

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U. S. Environmental Protection Agency, 1979. *Water-Related Environmental Fate of 129 Priority Pollutants, Volume I, Introduction and Technical Background, Metals, and Inorganics, Pesticides and PCBs.*

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# APPENDIX A-1
# COST ASSUMPTIONS FOR SITE 1 AND AOC B

Note 1 Estimated cost (actual cost unknown).

Note 2 Assumes installation of one well at a depth of 40 ft.

Note 3. Assumes sampling of the three surface samples. Soil samples will be analyzed for metals.

Note 4. Soil samples will be tested for lead, arsenic, chromium, and zinc.

Note 5. Assumes sampling of five existing wells on an annual basis. Groundwater sampling will be analyzed for VOCs, SVOCs, and metals.

Note 6. Cap maintenance will include mowing and general up keep.

Note 7. Uses Fixed Capital Ratio Method from "*Plant Design and Economics for Chemical Engineers*", Third Edition, McGraw-Hill Book Company, Pg. 179, Table 17.

Note 8. Treatment cost includes the utility service and resin replacement costs.

Note 9. Maintenance costs are based on 5% of the capital equipment and installation cost plus labor to maintain the unit at one operator per week at $45 per hour.

Note 10. Site wide groundwater modeling will be performed for the entire Kellogg base.

Note 11. Influent and effluent sampling will occur monthly, analysis will include tetrachloroethene, phenanthrene, and arsenic.

Note 12. Cost includes the preparation of Work Plans/Sampling Plans for pre-design well installation and soil investigation. Cost also includes preparation of Work Plans/Sampling Plans for the 5-Year Reviews.

Note 13. In addition to the costs listed in Note 12 above, this cost includes Work Plan/Sampling Plan for monitoring of influent/effluent streams to the treatment system.

Note 14. Mobilization/Demobilization costs are assumed to be 5% of the construction costs. This includes all up-front costs for the contractor including general set-up costs, temporary facilities, preparation of plans and submittals, and preparation of contractor Health & Safety Plan.

# APPENDIX A-2
# COST ASSUMPTIONS FOR SITE 3

Note 1 Estimated cost (actual cost unknown).

Note 2 Assumes sampling of 12 soil samples. Six will be surface and six will be subsurface.

Note 3. Soil samples will be tested for antimony, barium, cadmium, lead, and zinc.

Note 4. Assumes sampling of six existing wells on an annual basis. Groundwater sampling will be analyzed for VOCs, SVOCs, and metals.

Note 5. Uses Fixed Capital Ratio Method from "*Plant Design and Economics for Chemical Engineers*", Third Edition, McGraw-Hill Book Company, Pg. 179, Table 17.

Note 6. Cap maintenance will include mowing and general up keep.

Note 7. Treatment cost includes the utility service and resin and carbon replacement costs.

Note 8. Maintenance costs are based on 5% of the capital equipment and installation cost plus labor to maintain the unit at one operator per week at $45 per hour.

Note 9. Site wide groundwater modeling will be performed for the entire Kellogg base.

Note 10. Influent and effluent sampling will occur monthly, analysis will include trimethylbenzenes, benzene, cis-1,2-dichloroethene, and antimony.

Note 11. Cost includes the preparation of Work Plans/Sampling Plans for pre-design soil investigation. Cost also includes preparation of Work Plans/Sampling Plans for the 5-Year Reviews.

Note 12. In addition to the costs listed in Note 11 above, this cost includes Work Plan/Sampling Plan for monitoring of influent/effluent streams to the treatment system.

Note 13. Mobilization/Demobilization costs are assumed to be 5% of the construction costs. This includes all up-front costs for the contractor including general set-up costs, temporary facilities, preparation of plans and submittals, and preparation of contractor Health & Safety Plan.

# APPENDIX A-3
# COST ASSUMPTIONS FOR AREA OF CONCERN A

Note 1 Estimated cost (actual cost unknown).

Note 2 Assumes installation of two wells at a depth of 35 ft each.

Note 3. Assumes sampling of the two wells which were previously installed. Analysis will include VOCs, SVOCs, and metals.

Note 4. Soil samples will be tested for leaching of phenanthrene, antimony, lead, arsenic, chromium, and barium.

Note 5. Assumes sampling of two existing wells on an annual basis. Groundwater sampling will be analyzed for VOCs, SVOCs, and metals.

Note 6. Uses Fixed Capital Ratio Method from "*Plant Design and Economics for Chemical Engineers*".

Note 7. Maintenance includes mowing and removal of plants with substantial root systems (i.e., trees).

Note 8. Cost includes the preparation of Work Plans/Sampling Plans for pre-design well installation, groundwater investigation, and soil sampling. Cost also includes preparation of Work Plans/Sampling Plans for the 5-Year Reviews.

Note 9. Mobilization/Demobilization costs are assumed to be 5% of the construction costs. This includes all up-front costs for the contractor including general set-up costs, temporary facilities, preparation of plans and submittals, and preparation of contractor Health & Safety Plan.

# PUBLIC MEETING MINUTES - FEASIBILITY STUDY

MICHIGAN AIR NATIONAL GUARD
110th FIGHTER GROUP
BATTLE CREEK, MICHIGAN

Contract No: DAHA90-94-D-0013
Delivery Order No: 13

*Prepared For:*

Air National Guard
Andrews AFB, Maryland

*Prepared By:*

Montgomery Watson
Novi, Michigan

**Public Meeting Minutes - Feasibility Study**
**December 12, 1995**
**110th Fighter Group**
**W.K. Kellogg Memorial Airport**
**Battle Creek, Michigan**

**Meeting Attendees:**

| | |
|---|---|
| Fred Vollmerhausen | Air National Guard (110th Fighter Group) |
| Paul Wheeler | Air National Guard Readiness Center |
| Margaret Moffett | National Guard Bureau |
| Doug Barber | Montgomery Watson |
| Ben McGeachy | Montgomery Watson |
| 1 Unidentified Citizen | |
| 2 Members of the Channel 41 News Team | |

**Meeting Minutes:**

These minutes document the Public Meeting held to solicit comments on the Feasibility Study completed for Site 1, Site 3, Area of Concern A, and Area of Concern B at the Kellogg Memorial Airport in Battle Creek, Michigan. The meeting was held on December 12, 1995 from 7:00 PM through 8:30 PM at the American Legion Hall located on Columbia Avenue in Battle Creek. Present to discuss the Feasibility Study were: Captain Frederick Vollmerhausen of the Air National Guard (Base Environmental Manager), Paul Wheeler of the Air National Guard (Installation Restoration Program Project Manager), Margaret Moffett of the Air National Guard (Office of Public Affairs/Environmental Program), and Doug Barber and Ben McGeachy of Montgomery Watson (Feasibility Study Consultant).

The meeting was attended by one unidentified citizen and two members of the television station Channel 41 news team. Members of the Air National Guard and Montgomery Watson discussed the Feasibility Study with the unidentified citizen covering topics such as: overview of the Feasibility Study, impacted media and extent of impacts, cost of remediation, duration of remediation, and proposed and selected remedies. The unidentified citizen declined to have his name or any of his comments recorded for the public record. The two members of the news team filmed a brief portion of the meeting, narrated by Captain Vollmerhausen, for their 11:00 PM newscast.

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# RESPONSIVENESS SUMMARY - FEASIBILITY STUDY - PUBLIC MEETING

MICHIGAN AIR NATIONAL GUARD
110th FIGHTER GROUP
BATTLE CREEK, MICHIGAN

Contract No: DAHA90-94-D-0013
Delivery Order No: 13

*Prepared For:*

Air National Guard
Andrews AFB, Maryland

*Prepared By:*

Montgomery Watson
Novi, Michigan

**Responsiveness Summary**
**Feasibility Study - Public Meeting**
**110th Fighter Group**
**W.K. Kellogg Memorial Airport**
**Battle Creek, Michigan**

This document is intended to addresses public comments concerning the Feasibility Study completed for Site 1, Site 3, Area of Concern A, and Area of Concern B at the Kellogg Memorial Airport in Battle Creek, Michigan. A public review/comment period extended from November 30, 1995 through December 30, 1995. During this period, copies of the Feasibility Study were made available to the public through a local library. Additionally, notices were placed in local newspapers to solicit comments. A Public Meeting was held on December 12, 1995.

The Public Meeting was attended by one unidentified citizen and two members of the television station Channel 41 news team. Members of the Air National Guard and Montgomery Watson discussed the Feasibility Study with the unidentified citizen. The unidentified citizen declined to have his name or any of his comments recorded for the public record. The two members of the news team briefly filmed a portion of the meeting for their newscast.

No public comments were generated as a result of the Public Meeting or the public review/comment period.

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